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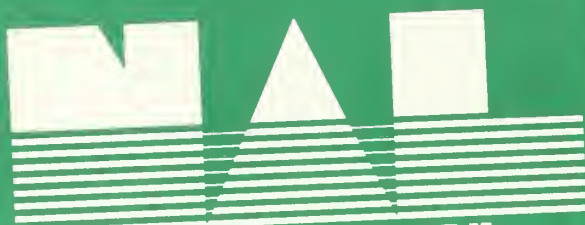
WORK PLAN



SNYDER, MIFFLIN AND UNION COUNTIES
PENNSYLVANIA

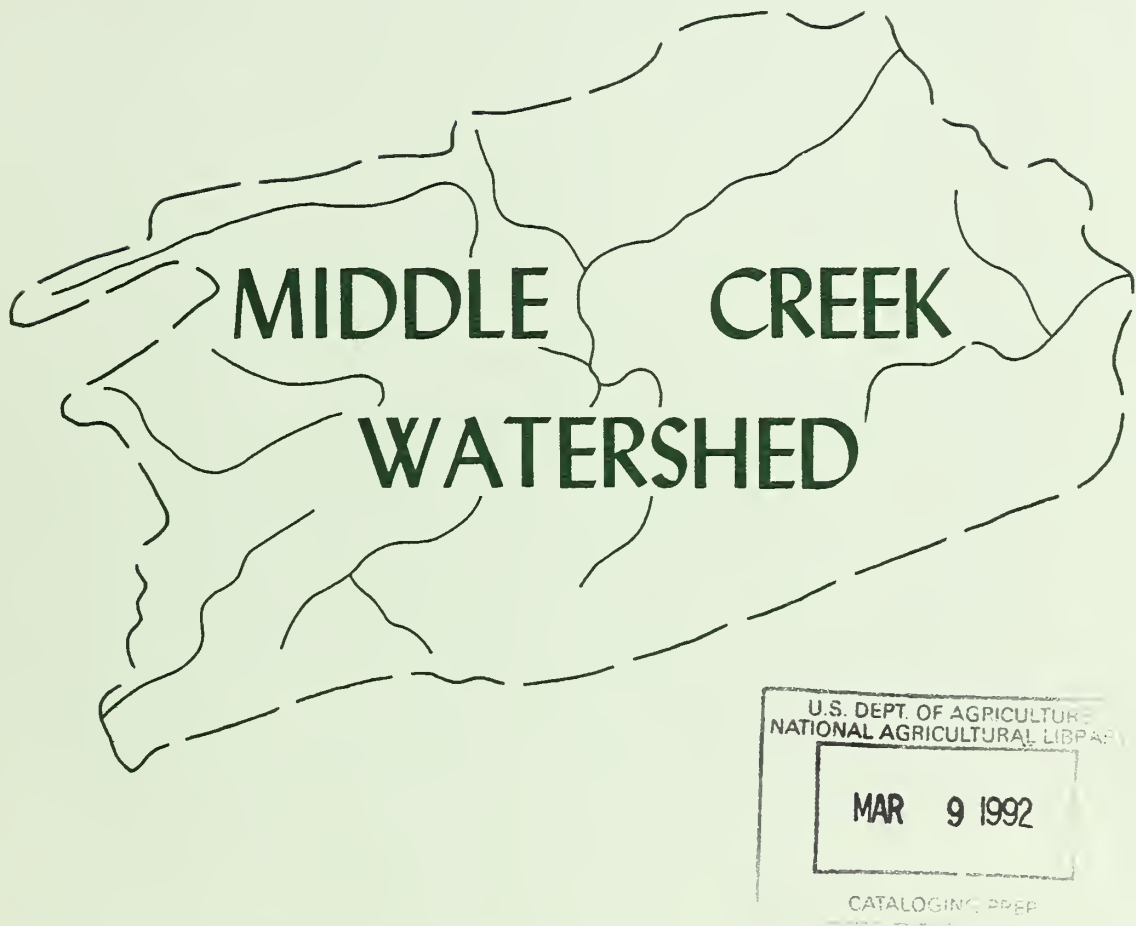
February 1965

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WORK PLAN



SNYDER, MIFFLIN AND UNION COUNTIES
PENNSYLVANIA

February 1965

WATERSHED WORK PLAN

MIDDLE CREEK WATERSHED

Snyder, Mifflin, and Union Counties, Pennsylvania

Prepared Under the Authority of the Watershed
Protection and Flood Prevention Act (Public
Law 566, 83d Congress, 68 Stat. 666), as
amended.

Prepared by: Snyder County Soil and Water Conservation District
Snyder County Commissioners
Beavertown Borough Council
Middleburg Borough Council
Spring Township Supervisors
Pennsylvania Fish Commission
Pennsylvania Department of Forests and Waters

With assistance by:

U. S. Department of Agriculture, Soil Conservation Service

U. S. Department of Agriculture, Forest Service

February 1965

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WATERSHED WORK PLAN

MIDDLE CREEK WATERSHED

Snyder, Mifflin, and Union Counties, Pennsylvania

February 1965

SUMMARY OF PLAN

The Middle Creek watershed as described in this plan terminates at the eastern limits of the borough of Middleburg immediately below the confluence of Stump Run with the main stem. The watershed drains an area of 84,096 acres (131.4 sq.mi.) of which 98 percent is in Snyder County with the remaining acreage in Union and Mifflin Counties.

The sponsoring local organizations are the Snyder County Soil and Water Conservation District, Snyder County Commissioners, Beavertown Borough Council, Middleburg Borough Council, Spring Township Supervisors, Pennsylvania Fish Commission, and the Pennsylvania Department of Forests and Waters. There are no sponsors in Mifflin or Union Counties because of the limited acreage of the watershed in those counties and because no works of improvement are needed.

The primary problem in the watershed is floodwater damage at Middleburg and vicinity. Other problems include flood damage in the communities of Beavertown and Beaver Springs, agricultural damages on the flood plains, and erosion in the uplands. In addition, an expanded water supply is needed in the Beavertown area and there is a demand for water-oriented recreational facilities.

The flood of November 2, 1956 resulted from a storm which produced 4.6 inches of precipitation in 30 hours. This storm was a ten-year frequency event. Total damage from this flood was estimated at \$97,736. Records indicate that this flood was exceeded by four floods in the last 38 years.

A comprehensive plan for development of the water resources has been prepared by the sponsors with the assistance of the U. S. Soil Conservation Service and the U. S. Forest Service. Other state and federal agencies were consulted, including the U. S. Fish and Wildlife Service, the U. S. Agricultural Stabilization and Conservation Service, and the Pennsylvania Game Commission.

This plan includes conservation land treatment and provides for one single purpose floodwater detention structure, one multiple purpose structure with flood prevention and recreation development, and one multiple purpose structure with flood prevention and municipal water supply. It also includes a bypass channel at the community of Beaver Springs and a dike and channel improvement in the borough of Middleburg.

The work plan proposes installing in a ten-year period a project for protection and development of the watershed at a total estimated installation cost of \$3,075,300. The share of this cost to be borne by Public Law 566 is \$2,076,135, with the remaining \$999,165 borne by local and other funds.

The sponsors are also responsible for the operation and maintenance costs. The annual operation and maintenance costs of \$27,365 capitalized over the evaluation period of the project amount to \$835,317. The sponsors share of the costs including capitalized operation and maintenance costs is 47 percent of the total project costs.

Land Treatment Measures

The cost for land treatment is estimated to be \$371,830, of which \$302,890 will be borne by local and other funds. Public Law 566 funds in the amount of \$68,940 will be used for accelerating technical assistance and will consist of \$59,540 for the use of the Soil Conservation Service and \$9,400 for the use of the Forest Service.

Structural Measures

Structure PA-636 will be a single purpose flood prevention structure.

Structure PA-637 will be a multiple purpose flood prevention and recreational development which will have a 230-acre permanent pool. It will include basic recreation facilities for fishing, boating, swimming, and picnicking.

Structure PA-638 will be a multiple purpose flood prevention and water supply structure. It will contain 18 million gallons of water to serve as a water supply for the borough of Beavertown.

Structure PA-639 will be a floodway channel and structure PA-640 will consist of dike construction and channel improvement.

Dams control 56.04 sq. mi. of the drainage area and provide storage for 8,895 acre feet of floodwater, 770 acre feet for sediment, 2,445 acre feet for recreational development, and 56 acre feet for municipal water supply.

The total installation cost of these structures is estimated to be \$2,703,470. Of this amount, Public Law 566 will provide \$2,007,195 and the sponsors will provide \$696,275.

Damages and Benefits

The estimated average annual direct and indirect floodwater damage without the project is \$88,240. The average annual damage remaining with the project installed is \$1,780.

The average annual benefit accruing to the structural measures is \$322,055 and to land treatment measures is \$2,250. These benefits

include \$86,170 for floodwater damage reduction, \$3,135 for more intensive land use, \$190,000 for recreation, \$7,200 for water supply, \$26,650 for secondary benefits, and \$8,900 for redevelopment benefits.

The ratio of the average annual structural benefits to the estimated average annual cost is 2.8:1.0.

The total benefits of land treatment measures were not evaluated in monetary terms.

Provisions for Financing Construction

Structure PA-636

The Snyder County Commissioners will be responsible for land, easements and rights-of-way, and administration of contracts. Land rights' costs, including relocation of electric telephone utilities and a portion of State Highway LR 54025, are \$180,738 and the costs of administration of the contracts are \$7,000.

Structure PA-637

The Pennsylvania Fish Commission will be responsible for the local share of land, easements and rights-of-way and a portion of the local share of the cost of construction and installation service costs of the associated recreation facilities.

The Pennsylvania Department of Forests and Waters and/or the Water and Power Resources Board will be responsible for the local share of the recreation construction costs and a portion of the construction and installation service costs of the associated recreation facilities.

The division of local costs for the associated recreation facilities is spelled out in more detail in the Project Installation portion of the work plan.

The Pennsylvania Department of Forests and Waters and/or the Water and Power Resources Board will be responsible for the administration of contracts for the construction of PA-637.

The Pennsylvania Department of Forests and Waters and the Pennsylvania Fish Commission will be responsible for administration of contracts for those associated recreation facilities for which they will pay the local share of the construction costs.

The local share includes \$93,855 for land rights, \$91,155 for recreation construction, \$254,630 for construction and engineering services of the associated recreational facilities, \$6,000 for administration of the contract for recreation construction, and \$6,000 for administration of the contracts for associated recreation facilities.

Structure PA-638

The Beavertown Borough Council will be responsible for land, easements and rights-of-way, the local share of construction and engineering services' costs, the specific costs, and administration of the contracts. Land rights' costs are \$15,150, local share of the construction and engineering services' costs are \$23,747, specific costs are \$2,500, and administration of contracts' costs are \$4,000.

Structure PA-639

Spring Township Supervisors will be responsible for land, and easements and rights-of-way at a cost of \$4,500, and the administration of contracts at a cost of \$1,000.

Structure PA-640

The Middleburg Borough Council will be responsible for land, easements and rights-of-way, and administration of contract. Land rights' costs are \$3,500, and administration of contract costs are \$2,500.

Operation and Maintenance

Land treatment measures will be maintained by the landowners and operators under agreement with the Snyder County Soil and Water Conservation District.

The Snyder County Commissioners will be responsible for the operation and maintenance of PA-636 at an estimated annual cost of \$800.

The Pennsylvania Fish Commission will be responsible for the operation and maintenance of PA-637 and the associated recreation facilities established for fishing and boating until that time at which the Pennsylvania Department of Forests and Waters enters into a contract to establish the general recreation development. When the recreation facilities associated with this general development are completed, the Pennsylvania Department of Forests and Waters will assume the entire responsibility for operation and maintenance of PA-637 and all of the recreation facilities.

The Beavertown Borough Council will be responsible for the operation and maintenance of PA-638 including the water supply features at an estimated annual cost of \$500.

The Spring Township Supervisors will be responsible for the operation and maintenance of PA-639 at an estimated annual cost of \$1,170.

The Middleburg Borough Council will be responsible for the operation and maintenance of PA-640 at an estimated annual cost of \$3,850.

DESCRIPTION OF THE WATERSHED

Physical Data

The Middle Creek watershed is located in Snyder, Union, and Mifflin Counties in central Pennsylvania. The watershed area is 84,096 acres (131.4 sq.mi.) of which 1,645 acres are in Mifflin County and 473 acres are in Union County, with the remaining 81,978 acres in Snyder County. The downstream boundary of the watershed area is located just below the Borough of Middleburg at the confluence of Stump Run with the main stem. Middle Creek then flows twelve miles in an easterly direction where it enters Penns Creek in the vicinity of Selinsgrove, Pennsylvania. Penns Creek enters the Susquehanna River one mile below this confluence.

The topography in the northern and southern sections of the watershed is generally steep with narrow ridges. The center of the watershed is characterized by lower ridges and valleys which become less abrupt in its lower limits. Elevations range from 500 feet at Middleburg to 2,100 feet above sea level on the northern boundary.

Agricultural enterprises are located throughout the central portion of the watershed with most farms being concentrated in the limestone areas. Most of the flood plain of Middle Creek is devoted to farming enterprises. Several small communities occupy portions of the flood plain with the largest of these being the county seat of Middleburg.

Geology

The watershed lies in the ridge and valley physiographic province of central Pennsylvania and is formed by a synclinal valley. It is enclosed by Shade Mountain and Jacks Mountain, moderately-high ridges of quartzitic sandstone. Ridges of sandstone or chert between the mountains break up the low-lying shale and limestone valley.

The streams of the watershed tend to follow the geologic structure by generally running parallel to the almost easterly strike and having their beds on the softer limestone and shales. In these softer rock strata, moderately-wide, fertile flood plains have been formed. In contrast, the tributaries are swift and steep and have formed little or no flood plain.

Some effects of glaciation are indicated by the formation of high terraces well above present valley bottoms. Coarse deposits of cobbles, boulders, and gravels overlie the area in some locations; some sources have assigned their origin to the Jerseyian Drift.

Soils

The soils of the watershed upstream from Middleburg are moderately deep to shallow, well-drained and moderately sloping. These soils were developed mostly from gray shales and sandstones with small areas of cherty limestone and calcareous shale. In a few places, the soils are developed from red shale.

The Montevallo, Hartleton, and Comly soils occupy low-shale ridges and rounded hills in the central part of the valley. Within the valley are small areas of Elliber and Kreamer soils developed on cherty limestone. Also scattered through the valley are small areas of shallow red soils of the Teas series. The deep Allenwood, Watson, and Alvira soils are developed on deep deposits of pre-Wisconsin glacial till or colluvial materials that have accumulated at the foot of Shade Mountain and Jacks Mountain. Moderately-deep to shallow, generally stony, Dekalb soils are on the upper slopes of these mountains. Lindside and Melvin soils are most common along the flood plains of lower Middle Creek, while Philo and Atkins soils are common in the headwaters above Beaver Springs.

Water

The headwater streams of Middle Creek have their sources on Jacks Mountain, near the northern border of Snyder County, and on Shade Mountain, near the southern border of Snyder County. These mountain tributaries with stream gradients up to 20 percent form the major tributaries of Middle Creek. The north branch of Middle Creek, Beaver Run, and Swift Run join Middle Creek approximately two miles north of Beavertown. The main stream then continues to flow eastward at an average gradient of 0.1 percent. Middle Creek empties into Penns Creek south of Selinsgrove on the flood plain common to these streams and the Susquehanna River.

Climatological

Precipitation averages 41 inches annually with about 17 inches falling during the growing season. The yearly temperature averages 50°F with extremes ranging from 27°F below zero to 105°F above. The frost-free growing season averages 130 to 170 days.

Land Use and Cover Conditions

Land use in the watershed is estimated to be 30 percent cropland, 4 percent pasture, and 64 percent woodland, with the remaining 2 percent in idle land, streams, roads, and towns.

About 70 percent of the watershed is in farmland. The cropland acreage of 25,200 acres is utilized for general farm crops and forage crops to support the livestock enterprise. A small acreage of farmland is devoted to vegetable growing and orchard crops.

The farmland is generally being used within its capability limitations and there is no area requiring critical area treatment. The Conservation Needs Inventory indicates that 80 percent of the cropland is in capability classes I to IV. The trend on the upland farms is to convert cropland to hay and improved pasture and to develop a good grassland program. About 1,000 acres of agricultural land are located on the flood plain. A portion of this land is restricted in use at the present time because of the flood hazard.

Approximately 64 percent, or 53,400 acres of the watershed, is in forest cover. Hardwood stands, which occupy 59 percent of the area, consist of the chestnut oak, red oak, scrub oak, and white oak types with associates of yellow poplar, basswood, ash, aspen, and red maple. Mixed stands of hemlock, white pine, Virginia pine, pitch pine, and above hardwood species occupy 34 percent of the area. The remaining 7 percent contains pure softwood stands of hemlock, white pine, Virginia pine, or established plantations. Approximately 31 percent of the forest area supports timber stands of 1,500 board feet or more per acre. Sixty-two percent is in pole-size stands, 4 percent is in stands consisting of seedlings and saplings, and 3 percent is in non-productive stands.

There are approximately 22,500 acres of state-owned forest land in the watershed administered by the Pennsylvania Department of Forests and Waters. This includes about 500 acres in the Snyder-Middleswarth State Park. An additional 1,225 acres are state game lands administered by the Pennsylvania Game Commission. The remaining woodlands are in private ownership.

Adequate forest fire protection is provided by the Pennsylvania Department of Forests and Waters in cooperation with the U. S. Forest Service under the Clarke-McNary Act.

These lands are well suited for the production of timber products, and under protection and management, the improvement of forest hydrologic conditions is expected.

Economic Data

The watershed is rural in character with the largest community, Middleburg, located at the lower boundary. The communities of Beavertown, Beaver Springs, and Troxelville are in the central part of the watershed with McClure being located near the western boundary. Middleburg is the center of activities throughout the watershed and surrounding area.

Total population in the watershed is estimated to be 7,000 with rural residents comprising 70 percent of this total.

Industrial activity is concentrated in the Middleburg area, although several small industries are located in the other communities of the watershed. Among the products produced are shoes, leather, canned food, garments and bricks. Statistics from the Pennsylvania Department of Internal Affairs indicate that manufacturing industries in Snyder County employ approximately 2,000 people with an annual payroll of \$5,920,000. The annual value of the production and related activities is \$16,430,000. It is estimated that the watershed area is responsible for about 35 percent of the manufacturing activity in the county. The county ranks 59th of the 67 Pennsylvania counties in the value of its manufacturing production.

Snyder County has been certified for assistance under Section 5a of the Area Redevelopment Act of 1961 indicating an unemployment rate above the national average.

Agriculture plays an important role in the watershed. There are about 500 farms averaging 110 acres in size. The average value per farm and buildings is \$11,300. Snyder County ranks 59th of the 67 counties in the state in this respect according to the Pennsylvania Department of Agriculture. The annual value of agricultural production in the county is estimated to be \$8,538,000 with approximately 40 percent of this production being within the watershed. Receipts from poultry, dairy and other livestock enterprises are the most important in that order. The county ranks 33rd in farm cash receipts although it is ranked 43rd in land in farms in the state. This indicates that agricultural productivity is higher than the state average.

The agricultural census indicates that more than half of the 1,200 farm operators work off the farm with 38 percent of the farm operators working off the farm more than 100 days. Income from off-farm work exceeds the value of farm products sold on 40 percent of Snyder County farms.

Most farms in the county are operating as family farm units. Only six farms hire farm managers with two of these being institutional farms. Census figures indicate that family workers compose 94 percent of the farm labor force. Eighty-one farms reported regular hired workers with only ten of these reporting more than one hired worker.

The watershed comprises 40 percent of the county area and represents a cross section of the county's agriculture.

Market conditions are favorable for the sale of sawlog materials at nearby mills. Hard and softwood pulpwood is marketable at Sunbury and softwood at Tyrone.

The Snyder County Soil and Water Conservation District has been in operation eight years. An active program is being carried out throughout the district. In the watershed area, 90 farmers have developed conservation farm plans on 13,400 acres of farmland. This comprises 25 percent of the private land in the watershed. Approximately 40 percent of the land treatment needs have been met on these farms. Table 1a indicates the type and amount of land treatment measures installed on these farms.

Wildlife resources in the watershed are important and attract both large and small game hunters. Deer are found in substantial numbers and small game species include rabbits, squirrels, ring-necked pheasants, ruffed grouse, and wild turkey.

The fishery resources are limited to several trout streams including Middle Creek, North Branch Middle Creek, and Swift Run which are open to the public and are stocked with trout by the Pennsylvania Fish Commission.

U. S. Route #522 and State Route #104 intersect in Middleburg and make the watershed easily accessible by road. Other good secondary roads are found throughout the watershed. Average farm-to-market distance is about 15 miles.

The Pennsylvania Railroad provides service to Middleburg, Paxtonville, and Beavertown.

WATERSHED PROBLEMS

Floodwater Damage

Flooding in the watershed has long been a serious problem. Major floods occurred in 1889, 1927, 1933, 1936, 1942, 1952, and 1956.

The flood of November 2, 1956 has been selected as the key flood for the damage analysis. It was produced by 4.6 inches of rainfall over a 30 hour period falling on soil of average moisture content. Its frequency of occurrence is estimated to be ten years.

Average annual direct damage in the watershed is estimated to be \$74,880.

The main damage center is Middleburg. The 1956 flood inundated 47 acres causing damages estimated at \$46,930. This damage occurred to 48 residences, 17 commercial establishments, 3 industries, and to several streets. A 100-year flooding event would cause damages estimated to be \$1,900,000 and would affect more than 100 properties.

The communities of Beaver Springs and Beavertown also suffered heavy damage in the key storm. Flood damage of \$24,862 occurred in the Beaver Springs area and affected 39 residential and commercial establishments. Beavertown suffered \$3,734 of flood damage which affected 13 properties.

In addition, small amounts of damages occurred in the villages of McClure and Middle Creek.

The use of 500 acres of agricultural land on the flood plain is restricted because of flooding. Flooding affects only a limited number of farm buildings with most of the agricultural damage resulting from a decrease in crop and pasture production.

Indirect Damages

Indirect damages were estimated to be 15 percent of residential, 20 percent of the industrial and commercial, and 10 percent of the agricultural direct damage. These damages include delaying shipment of materials and products, loss of wages to employees, increased costs due to rerouting traffic, and interruption of public utilities and similar services.

Erosion Damage

Erosion problems in the watershed are not critical. Sheet erosion is noticeable on some cropland areas and gully erosion has developed along some steep waterways.

Streambank erosion occurs to some extent throughout the watershed. This erosion is taking place on low value land so the extent of its damage was not appraised nor considered to be an agricultural damage. Streambank erosion was considered as a sediment source in the design of the proposed reservoirs.

Sediment Damage

Sediment and erosion damage to the flood plain is moderate. Damages have generally occurred to low value land resulting in a low monetary damage. Damage due to sediment on flood plains was not evaluated separately due to its infrequent occurrence. However, it was reflected in the crop and pasture damage appraisal.

Sediment from various sources produces other damages associated with floodwater damage but because of the difficulty in separating them, they were evaluated as part of the total floodwater damage.

Annual sediment production, predominantly derived from sheet erosion, is 1.2 acre feet per square mile. Total combined average annual sediment yield at the proposed structures is calculated to be 7.4 acre feet.

Land Treatment

There are no critical land treatment problems within the watershed. The Conservation Needs Inventory indicates that approximately 30 percent of the cropland and 20 percent of the grassland acreage has received adequate treatment.

Agriculture in the watershed is stable. Census figures indicate that farm acreage has shown less than a five percent decrease in the last 20 years although the size of farms has increased by 32 percent. Land use adjustment, centered on the production of crops for livestock enterprises, has resulted in an increase in forage crops with a resulting decrease in grain crops. The greatest change has occurred in a 50 percent reduction of wheat acreage and a 400 percent increase in alfalfa acreage in the last ten years. The changes in land use have resulted in a steady and continuing decrease in land use classes IV and VI land being used as cropland.

The stability of the agricultural enterprises in the watershed has permitted the landowners to carry on land treatment measures. In addition, the Agricultural Stabilization and Conservation Service records indicate that an average of \$13,000 per year in cost sharing funds has been earned by farmers in the watershed over the last three years.

Problems Relating to Water Management

Water Supply

There are four water supply systems in the watershed which serve the communities of Middleburg, Beavertown, Beaver Springs, and Troxelville. More than 3,000 of the watershed residents are served by these facilities. Residents of smaller villages, and farm and rural residents obtain their water supply from wells and springs.

The Borough of Beavertown indicated a need for expansion of its present water supply system. They are presently being served by a storage reservoir of 200,000 gallons capacity located on a small tributary stream of Middle Creek. The consulting firm retained by the borough has indicated that this is not adequate for their needs and has indicated that future requirements will more than double.

Recreation Needs

There is an extensive acreage of state forest and state game lands in the watershed area, but there are no water-oriented recreation facilities for public use. The Pennsylvania Fish Commission does maintain and operate Middle Creek Lake, located outside the watershed boundary, as the only public lake in the county. Recreational use at this facility is limited to boating and fishing. The Susquehanna River which serves as the eastern boundary of Snyder County is polluted in this area and recreational use is limited to boating. Public officials at the local and the state level have expressed a need for water-oriented recreational facilities in the watershed. The population within a 25-mile radius of the watershed area is 152,000 people and it is estimated there is a need for 228,000 days of recreational use annually.

Water Quality

The only community with a sewerage system having treatment facilities at the present time is Middleburg. This system serves a population of 1,300. Planning is currently under way in other communities in the watershed to develop public sewerage and treatment facilities as required by state regulations.

PROJECTS OF OTHER AGENCIES

Minor stream clearance projects have previously been completed by the Pennsylvania Department of Forests and Waters and Pennsylvania Department of Highways on small sections of Middle Creek and its tributaries. No other water resource development measures which will affect the proposed program have been built or are planned within the watershed. The works of improvement set forth in this plan will constitute needed and harmonious elements in the Susquehanna River Basin.

BASIS FOR PROJECT FORMULATION

The sponsors desired protection from a 100-year frequency storm in the main damage center, Middleburg. They also desired protection of residential areas and businesses located in the small communities throughout the watershed and the agricultural lands affected by floodwaters of Middle Creek. The proposed plan will essentially accomplish the objectives of the sponsors throughout the watershed.

The objectives for land treatment and proper land use were also of prime consideration to the sponsors. The Snyder County Soil and Water Conservation District is currently developing a long-range district program. The directors' objectives have been and will continue to be desirable land use adjustments and use of the water resources to effect an improvement in the farm economy. Emphasis is being put on the development of water impoundment areas both public and private, and encouragement of the establishment of income-producing recreation enterprises based on these water developments.

The Soil and Water Conservation District directors have prepared goals which indicate that they will work closely with farmers and other landowners to bring about necessary land use adjustments and conservation treatment as quickly as resources permit. The land treatment portion of the work plan reflects these objectives.

The need for and interest by county government and state agencies in the development of water-oriented recreation facilities has resulted in the planning of PA-637 as a recreation structure. The 230-acre lake proposed will provide for a majority of the recreation needs. In addition, the sediment pool of structure PA-636 will be developed for recreation purposes.

Structure PA-638 includes 18 million gallons of storage for industrial and municipal water supply for Beavertown. A report on construction costs, transmission facilities, filtration facilities and maintenance of the structure was prepared by a consultant who was retained by the Beavertown Borough Council. The water supply features incorporated in this structure were based on this report and the sponsors estimate of storage required to provide for an adequate water supply during drought periods and anticipated needs for future requirements.

Alternate sites were located and studied during development of the plan. In addition to the sites proposed in the plan, engineering surveys and cost estimates were developed on seven additional sites. The sites discarded could not be justified because of the high construction costs and the limited benefits accruing to the structures.

The presence of limestone formations at three of the sites studied precluded their development due to extensive treatment requirements of foundations.

Minor flood damage occurs at the communities of McClure and Middle Creek but work of improvement could not be justified at these locations.

The combination of structural sites selected provided the necessary protection at the lowest cost of all alternate sites studied.

WORKS OF IMPROVEMENT TO BE INSTALLED

Land Treatment Measures

Land treatment measures will be installed for both watershed protection and flood prevention purposes. Land will be used within its capabilities and land treatment measures installed will be in accordance with needs and objectives to be accomplished.

Land treatment measures are the basic element of the watershed project, and were considered as the initial increment for project formulation. Emphasis will be placed on accelerating those measures which significantly affect the reduction of floodwaters and sediment yields. This will reduce the cost of providing sediment storage capacity behind the floodwater retarding structures.

A program to meet the land treatment needs has been developed as follows:

Open Land

Vegetative measures will be established to improve soil cover conditions and physical characteristics of the soil. This will decrease runoff and erosion and will assist in preventing sediment from filling stream channels and will result in less deposition on the flood plains. These measures include conservation cropping systems, stripcropping, seeding of improved grasses and legumes, and hayland and pasture renovation.

Establishment of diversions, grassed waterways, and terraces will have a measurable effect in reducing peak discharge by slowing runoff and will augment the soil improvement cover measures in reducing erosion damage and sediment yields. Installation of drainage measures on the poorly drained, more level soils will result in beneficial adjustments in land use by permitting retirement of upland soils which have a greater erodibility potential. The establishment of farm ponds will make livestock water more available and permit more intense pasture management which will result in less overgrazing, higher infiltration capacities, and a reduction in the erosion hazard.

The establishment and development of wildlife practices, such as wildlife habitat development, will provide improved cover conditions and will contribute to the perpetuation and expansion of the wildlife resources in the watershed.

The work plan proposes the completion of soil surveys within the watershed. Records indicate that 70,650 acres remain to be mapped. It is estimated that the amount of technical assistance needed to complete the soil mapping in the watershed is 2,000 hours.

The Snyder County Soil and Water Conservation District program and the technical assistance programs made available through the district all emphasize use of the land within its capabilities. The district program places emphasis on the production of forage crops with a resultant decrease in acreage of grain crops and will have a beneficial effect on land use adjustments.

Forest Land

To insure proper forest land treatment and maximum watershed protection, forest landowners will be provided technical assistance for tree planting, hydrologic cultural operations and woodland grazing control. These forestry practices will contribute to improved hydrologic conditions effective in reducing flood peaks, reduction of sedimentation, and in recharging ground water during the winter and spring.

Forest trees, through development of deep root systems, extend the soil zone available for storage of water. Thus, during the summer and fall flood season, evapotranspiration removes maximum volumes of water from the soil profile and creates optimum opportunity for the immediate storage of storm precipitation.

The forest cover, which contributes to lowering of water tables through evapotranspiration, also creates accumulations of litter and humus which protect the soil, increase surface infiltration and percolation rates, and increase soil moisture storage capacity, thereby reducing surface runoff contribution to flood flows.

Manipulation of stand composition creates favorable conditions for the maximum production and protection of litter, humus and forest cover. Control of woodland grazing results in the protection of vegetative cover from browsing and also prevents soil compaction from trampling. Ungrazed forest offers optimum conditions for infiltration and storage of water in the soil profile.

Structural Measures

Forty-three percent of the drainage area above Middleburg will be controlled by the following sites:

PA-636

This structure will be a single purpose flood prevention dam located on Middle Creek, just west of Route #235 and north of Beaver Springs. It will be 42 feet high and 1,400 feet long and will consist of 244,013 cubic yards of earth and rock fill. The

structure will control 33.15 square miles of drainage area and will store 5,000 acre feet of floodwater (the equivalent of 2.83 inches of runoff) below the crest of the emergency spillway. A two-stage principal spillway will be designed for a maximum high-stage discharge of 1,292 cubic feet per second. This will be accomplished by using two separate pipe and riser combinations, the low-stage having a 66-inch pipe and the high stage having a 72-inch pipe. A 200-foot emergency spillway will be cut into rock on the left abutment and a 150-foot emergency spillway will be cut into rock on the right abutment.

The sediment pool for this structure is planned to hold 90 percent of the sediment expected to accumulate in a 100-year period. The decision to construct this type sediment pool was made because of the unsatisfactory conditions created by a 50-year sediment pool. No additional federal funds will be used to enlarge the sediment pool. The additional two feet of water which results from increasing the sediment pool storage will eliminate unsatisfactory conditions.

It will be necessary to acquire 12 sets of buildings, to protect 4 buildings, to relocate electric and telephone lines, and to raise 2,500 feet of state highway at this site.

PA-637

This structure is planned as a multiple purpose flood prevention and recreational development dam. Located on the North Branch of Middle Creek below Troxelville, it will control drainage from 17.59 square miles. The dam will be 51 feet high and will consist of 261,800 cubic yards of earth and rock fill. It will be designed with a single stage riser, 60-inch pipe combination principal spillway, having a maximum release of 545 cubic feet per second.

The dam will store 3,130 acre feet of floodwater (the equivalent of 3.34 inches of runoff) below the crest of the emergency spillway. The 150-foot wide emergency spillway, located on the right abutment, will be cut partially into rock with a 30-foot level section of paved concrete extending approximately 20 feet into the exit channel.

The recreational development created by the dam will store 2,445 acre feet of water and provide a 230-acre lake. It will be necessary to acquire five buildings, relocate telephone and electric facilities, and abandon two sections of township road at this site.

The associated recreation facilities at PA-637 will be constructed on the upper northern end of the lake. In addition to the 230 acres in the permanent pool, an area of 235 acres will be acquired for these facilities. The type and amount of facilities to be installed and their location are shown in Table 2b and Figure 2.

PA-638

PA-638 is planned as a multipurpose flood prevention and water supply dam. It will be located on Kerns Run approximately one-half mile south of Beavertown Borough and will control drainage from 5.3 square miles. The dam will be 60 feet high and will consist of 187,000 cubic yards of earth and rock fill. It will be designed with a single stage riser, 36-inch pipe combination principal spillway, having a maximum release of 180 cubic feet per second. The dam will have the capacity to store 765 acre feet of floodwater and 56 acre feet of water for water supply development. A 150-foot wide emergency spillway will be cut into rock on the left abutment of the dam.

An outlet pipe is the only specific cost item planned in this structure.

It will be necessary to acquire one cabin and to relocate water supply transmission facilities of Beaver Springs and an access road to these facilities in the construction of this site.

PA-639

The flooding problem in Beaver Springs is caused by a tributary of Beaver Creek flowing through the town in a winding and restricted channel. This problem will be relieved by PA-639, a 30-foot wide floodway which will prevent floodwaters (a 100-year peak discharge from a drainage area of 1.26 square miles) from flowing through the town. It will originate at the bridge on Pennsylvania Route #235 west of Beaver Springs flowing north with straight alignment for 1,100 feet into Beaver Creek, passing east of the Beaver Springs Milk Plant and its parking facilities. A structure will be placed in the floodway to permit low flow (maximum of 30 cubic feet per second) to enter the old stream channel.

A channel ten feet wide, 100 feet long, 1:1 side slopes, will be constructed to carry the low flow from the floodway to the existing stream channel.

A low dike will extend from Route #235 to the floodway to guide any flow over the bridge on Route #235 back into the floodway and to prevent the overflow from entering the old stream channel. It will be necessary to remove the mill dam and reshape the channel north of the U. S. Route 522 bridge before constructing PA-639.

The sewage filtration field presently used by the Kinney Shoe Factory will be incorporated into a town sewage system; construction will be delayed until this occurs. The floodway crosses a section of tracks of the Pennsylvania Railroad which will be abandoned in the future. The railroad has initiated abandonment proceedings. Access to the milk plant and houses

west of the floodway will be provided by a road to be constructed west of the Kinney Shoe Factory. One barn will have to be acquired.

PA-640

PA-640 is planned as a 1,970 foot long dike, beginning about 50 feet east of the intersection of Furnace Road and Edmund Street, extending along the south side of Edmund Street, and then around the south side of the Middleburg Throwing Corporation, and continuing along the north bank of Middle Creek to the U. S. Route 522 bridge. The dike will be of earth construction except for a 100-foot concrete section west of the bridge. The section adjacent to the throwing factory will be diked by raising the existing gravel lane approximately 2.5 feet and may require a concrete cutoff. The dike is designed to handle a 100-year frequency storm after floodwater detention dams, PA-636, PA-637, and PA-638 have been constructed. The maximum height of the dike is approximately seven feet, which includes two feet of freeboard above the 100-year frequency flow line. Internal drainage facilities will be provided where needed for the area north of the dike. In addition to the dike, a 90-foot section of the south bank of Middle Creek west of the bridge will be stabilized with a concrete wall. Presently this section of the bank is encroaching upon the channel and reducing its capacity. Project PA-640 also necessitates snag and bar removal of the Middle Creek channel adjacent to the dike and one-half mile downstream from the Route 522 bridge. Construction of PA-640 will require relocation of one storage shed.

Structural design features common to the proposed dams are:

1. Sufficient capacity has been planned to store the estimated volume of sediment that will accumulate during a 100-year period from the individual drainage areas.
2. An emergency spillway which will pass the inflow in excess of detention storage and pipe release from a six-hour storm producing approximately 17 inches of runoff.
3. The detention storage and the principal spillway release will control a 100-year rainstorm on average antecedent soil moisture conditions based on Technical Release #10 procedure.
4. All structures are designed to release the flood detention storage in five days or less.

EXPLANATION OF INSTALLATION COSTS

Land Treatment

The unit costs for installation of land treatment measures were based on current costs of materials, equipment and services for similar work.

The cost of technical assistance for the installation of land treatment measures was based upon analysis of expenditures for this type of assistance and soil and water conservation districts' accomplishments for the past several years.

Costs for the installation of forest land treatment measures are based on current costs of supervision, labor, equipment, and materials needed for each measure. Costs of technical assistance are based on actual expenditures and accomplishments of the Pennsylvania Department of Forests and Waters. An analysis of costs against accomplishments was made for each measure to determine unit costs.

Structural Measures

Construction costs for the structural measures were based upon unit prices from recent contracts for comparable work. These estimates were based on a summation of the costs for clearing, grubbing, common excavation, compacted earth fill, drainage material, rock excavation, concrete pipe, seeding and mulching. The total construction cost estimates included 12 percent for contingencies. Installation service costs included estimates for detailed geologic investigations for each site. Other engineering and administrative services were estimated as a percentage of the construction cost based upon records of recent experience for similar work.

Land acquisition costs and values of the buildings affected by the structures were estimated by the County Assessor's office based on land values in the watershed. Relocation costs for electric and telephone utilities were based on estimates prepared by the sponsors and the utilities involved and reviewed by the Soil Conservation Service. Costs for the highway relocation were based on estimates prepared by the Pennsylvania Department of Highways and reviewed by the Soil Conservation Service.

Property survey costs to establish boundaries for land acquisition were based upon records of recent experience for similar work.

The estimated costs for administration of contracts and operation and maintenance were based upon records of these costs from similar projects in the state over the last three years.

The costs of the associated recreation facilities to be constructed in conjunction with PA-637 were provided by the Pennsylvania Department of Forests and Waters based upon their experience in the construction of similar facilities.

Public Law 566 funds will provide all of the flood prevention construction costs, 50 percent of the recreation construction costs and 50 percent of the cost of associated recreation facilities. They will also provide all engineering service costs for flood prevention and recreation construction and 50 percent of the engineering service costs for construction of the recreation facilities. In addition, 50 percent of the costs of land rights on site PA-637 for which fee title will be obtained (excluding costs of land survey, legal fees and other costs incident to acquiring these rights allocated to recreation) will be provided by Public Law 566 funds.

Fee title will be acquired for 465 acres which includes the area required for PA-637 and the recreation facilities. This will permit access to all portions of the lake and the recreation facilities. In addition, flooding easements will be acquired for 195 acres of land which is located in two arms of the pool. These easements will in no way restrict the use of PA-637 or its recreation facilities. Federal funds will not be used for the acquisition of flooding easements on the 195 acres.

The joint costs for structure PA-637 were allocated by the use of facilities method which apportioned 58.3 percent to flood prevention and 41.7 percent to recreation development.

The joint costs for structure PA-638 were allocated by the use of facilities method which apportioned 93.4 percent to flood prevention and 6.6 percent to water supply. Specific costs for items installed only for water supply were assigned in total to that purpose and will be paid for from other than Public Law 566 funds.

The following summarizes the construction schedule and the estimated installation costs:

<u>Year</u>		<u>Structural Measures</u>	<u>Treatment</u>	<u>Total</u>
1st	P. L. 566	50,000	5,000	55,000
	Other	150,000	20,000	170,000
	Yearly Total	<u>200,000</u>	<u>25,000</u>	<u>225,000</u>
2nd	P. L. 566	300,000	6,000	306,000
	Other	100,000	20,000	120,000
	Yearly Total	<u>400,000</u>	<u>26,000</u>	<u>426,000</u>
3rd	P. L. 566	300,000	8,000	308,000
	Other	50,000	27,000	77,000
	Yearly Total	<u>350,000</u>	<u>35,000</u>	<u>385,000</u>
4th	P. L. 566	300,000	8,000	308,000
	Other	50,000	32,000	82,000
	Yearly Total	<u>350,000</u>	<u>40,000</u>	<u>390,000</u>
5th	P. L. 566	300,000	7,000	307,000
	Other	50,000	32,000	82,000
	Yearly Total	<u>350,000</u>	<u>39,000</u>	<u>389,000</u>
6th	P. L. 566	200,000	7,000	207,000
	Other	20,000	35,000	55,000
	Yearly Total	<u>220,000</u>	<u>42,000</u>	<u>262,000</u>
7th	P. L. 566	100,000	7,000	107,000
	Other	30,000	35,000	65,000
	Yearly Total	<u>130,000</u>	<u>42,000</u>	<u>172,000</u>
8th	P. L. 566	300,000	7,000	307,000
	Other	100,000	35,000	135,000
	Yearly Total	<u>400,000</u>	<u>42,000</u>	<u>442,000</u>
9th	P. L. 566	100,000	7,000	107,000
	Other	100,000	35,000	135,000
	Yearly Total	<u>200,000</u>	<u>42,000</u>	<u>242,000</u>
10th	P. L. 566	57,195	6,940	64,135
	Other	46,275	36,890	83,165
	Yearly Total	<u>103,470</u>	<u>43,830</u>	<u>147,300</u>
Project)	P. L. 566	2,007,195	68,940	2,076,135
Period)	Other	696,275	302,890	999,165
Totals)		<u>2,703,470</u>	<u>371,830</u>	<u>3,075,300</u>

EFFECTS OF WORKS OF IMPROVEMENT

The projected 100-year frequency storm will be controlled by the proposed measures to the point of rendering negligible flood damage.

The main damage center of Middleburg which is affected by a five-year frequency flood at the present time will receive protection from a 100-year frequency flood with the exception of minor flood damage to lawns and gardens and a few basements in the lower end of Reach E. The average annual remaining damage in Middleburg is \$135.

Beaver Springs, which is affected by out-of-bank flooding every two years, will receive protection from a 100-year frequency storm with the exception of the portion of Beaver Springs which is located along Beaver Creek. In this area, works of improvement were not feasible and remaining average annual damage amounts to \$1,037.

Beavertown is affected by out-of-bank flooding every two years. Structure PA-638 will reduce flooding to once in ten years with remaining average annual damage of \$109.

The agricultural land located upstream from Middleburg will receive substantial protection. The majority of the 368 acres of agricultural land which will be protected is located in this area. There will be some reduction in crop and pasture damage in the areas below the watershed boundaries.

Further development or intensified use of land should be discouraged in those areas not receiving protection from the 100-year frequency flood. This includes areas indicated in this section of the plan and in addition much of the agricultural land on the flood plain located upstream from Middleburg and downstream from Middleburg to the community of Kantz. (See Figure 4, Flood Risk Map.)

Land treatment measures planned for the watershed will substantially reduce sediment and erosion damages. The program will have a direct beneficial effect on agricultural production in the flood plain areas which are being protected. Farm operators in this area have indicated that this land will be used for similar types of crops which are being produced at the present time. These include feed grains for on-farm consumption, corn for silage production, and hay crops for livestock enterprises.

The reduction in the flooding hazard on the benefited areas will increase the efficiency of the farms affected and permit more proper land use. Net returns in farm income are expected to increase as a direct result of the reduction of flood damage and because of more efficient operations which will permit reduction in operating costs.

It is expected that the development of public recreation facilities in the watershed will result in the development of on-farm, income-producing recreation facilities. The water-oriented public

facilities will serve as a nucleus for and provide opportunities for the development of private farm recreation. These developments will permit more efficient use of under-employed resources in the watershed.

Recreation

The construction of PA-637 will greatly increase water-oriented recreation facilities in the area. Hunting, fishing, swimming, ice skating, and boating opportunities will be provided for residents of Snyder County and areas outside the counties including the cities of Sunbury, Lewistown and Lewisburg. The lake and recreation facilities at PA-637 will be used throughout the year with major use anticipated in the 16-week summer season. The peak daily use is estimated to be 4,000 visitor days while the annual use is estimated to be 120,000 visitor days.

The 230-acre lake created by PA-637 will have five miles of shore line. Approximately 50 percent of the lake will be between five to 20 feet deep which is the optimum depth for fishery resource management. The lake will be stocked with warm water fish species including game fish. Fishing, boating, swimming, and picnicking facilities will be established and maintained for public use.

The 112-acre sediment pool at PA-636 will be maintained by the Snyder County Commissioners as a public recreation facility. Sufficient land will be acquired to permit limited recreation facilities to be developed and maintained for public use. The recreational facilities to be installed at this site will be the sole responsibility of the Snyder County Commissioners. Recreational use of the site will include fishing, boating, and picnicking facilities.

Water Supply

The construction of PA-638, a multiple purpose structure to include 56 acre feet of storage for municipal water supply, will provide 18 million gallons of water as a reserve for drought periods and for an anticipated increase in future needs. An assured water supply will assist in the orderly development of the community of Beavertown and will serve to encourage the establishment of industries in the community.

PROJECT BENEFITS

The total average annual project benefits accruing to the structural measures are \$322,055 and to land treatment measures are \$2,250.

The average annual floodwater damage without the project is estimated to be \$88,240. The average annual damage is reduced to \$1,780 with the project installed. Average annual flood prevention benefits including land enhancement are \$91,555.

As indicated in Table 5, flood prevention benefits are 35 percent to residences, 55 percent to business and industry, five percent to agriculture, and five percent to railroads, roads, and bridges.

Average annual benefits of \$7,200 were assigned to municipal water supply. Benefits for water supply were arrived at by a consultant retained by Beavertown.

Recreation benefits were assigned to the state park facilities to be developed at Site PA-637 and to the recreational activities to be developed in conjunction with the sediment pool at PA-636. The Snyder County Commissioners have indicated that sufficient land will be obtained in the area of PA-636 to permit development of limited public recreational facilities. The facilities at PA-637 were designed to permit 120,000 recreation days of use annually at a benefit of \$180,000. Public recreation use at PA-636 was estimated at 10,000 recreation days annually with an annual benefit of \$10,000. Associated costs of the recreation facilities at PA-636 were considered in developing the incidental benefits.

Additional benefits to fish and wildlife will result from increasing their habitat, increasing productivity of existing habitat, and making it available for public use. Land treatment measures planned will also improve wildlife habitat by providing better food and cover conditions. These benefits were not included in the evaluation.

The proposed forest land treatment measures will improve the hydrologic condition and productivity of the forest land. This will reduce sediment and retard runoff. Good management and continued fire protection will increase the productivity of the forest land.

Snyder County has been designated as a section 5a county under the Area Redevelopment Act. Benefits resulting from increased labor resources required for project construction and operation and maintenance have been assigned. In addition, benefits resulting from added area employment resulting from opportunities created by the project were also assigned. The evaluation of these benefits was limited to the first 20-year period of the project. The redevelopment benefits stemming from increased labor use are \$8,900. Because of chronic unemployment of labor resources in the area, each added unit of employment is significant.

Secondary benefits were evaluated in monetary terms and included in the economic justification of the project. The value of local secondary benefits stemming from the project, \$26,650, were considered to be equal to ten percent of the direct primary benefits. They included the proposed expansion of residential development in the areas adjacent to the recreation development and the establishment of private service industries in conjunction with the recreation development. Secondary benefits from the national viewpoint were not considered pertinent to the economic evaluation.

Non-monetary benefits will also accrue from the knowledge that businesses and homes are protected from flood loss and the peace of mind this affords. This fact will increase the spirit and effectiveness of all activities in the watershed.

COMPARISON OF BENEFITS AND COSTS

The structural measures described in this work plan are economically justified.

The ratio of the primary average annual structural benefits (\$295,405) without the inclusion of local secondary benefits, to the estimated average annual costs (\$115,930) is 2.6:1.0.

The total average annual benefits, including local secondary benefits of \$26,650, are \$322,055. The benefit cost ratio is 2.8:1.0. Table 6 shows a comparison of annual costs to annual benefits.

PROJECT INSTALLATION

The installation period for accomplishing the plan will be ten years. The order of priority recommended for installation is PA-636, PA-637, PA-638, PA-639, PA-640, and associated recreation facilities at PA-637.

The Snyder County Soil and Water Conservation District will be responsible for working with landowners and operators to carry out the land treatment measures to be established within the next ten years. The Soil and Water Conservation District, with the assistance of the Soil Conservation Service, will assist landowners and operators co-operating with the district in the preparation and application of farm conservation plans.

Fifty percent of the farm land in the drainage area above each flood retarding structure will be under cooperative agreement with the Soil and Water Conservation District before construction of the dams can be initiated. Technical assistance to district cooperators will be accelerated under the Public Law 566 program as set forth in this work plan. Provisions for carrying out this accelerated program will be included in the annual work plans of the Soil and Water Conservation District. The forest land treatment measures will be installed by the landowners and operators with technical assistance furnished by the Pennsylvania Department of Forests and Waters in cooperation with the U. S. Forest Service.

Records of the Snyder County Soil and Water Conservation District indicate that almost 50 percent of the farm land in the drainage area above structure PA-636 is now under cooperative agreement. The district directors have agreed that a program of assisting farmers in the drainage area above PA-637 has the highest priority. Provisions for carrying out this accelerated program will be included in the annual work plans of the Snyder County Soil and Water Conservation District.

The annual work plans will also include goals for the establishment of land treatment practices. Land use adjustments and other conservation activities set forth in the work plan will be met within the program period.

The Agricultural Extension Service of the Pennsylvania State University through the County Agricultural Extension Agents, will assist the Soil and Water Conservation District in developing and carrying out an information and education program to stimulate interest in watershed activities.

The Snyder County Commissioners will be responsible for the acquisition of land rights, including highway and utility relocations, and administration of the contracts for site PA-636.

The Pennsylvania Fish Commission will be responsible for the local share of land rights for PA-637 including the entire cost of 195 acres of land on which flooding easements may be obtained. They will pay all costs for land surveys, legal fees, or other costs incident to acquiring the land rights.

The Pennsylvania Department of Forests and Waters and/or the Water and Power Resources Board will be responsible for the local share of the recreation construction costs and the administration of contracts for the construction of PA-637.

The Pennsylvania Fish Commission will be responsible for the local share of the construction, all engineering services, and administration of contracts' costs for those associated recreation facilities which will be established for fishing and boating use. These facilities include the boat docks and boat ramp as indicated in Table 2b and sanitary facilities to be established in conjunction with the boating area. The cost of these facilities is estimated to be \$15,000 for the boating facilities and \$1,000 for the sanitary facilities.

The Pennsylvania Department of Forests and Waters will be responsible for the local share of the construction, engineering services, and administration of contracts' costs for those associated recreation facilities which will be established in the second phase of the recreation development program at PA-637. This phase will be initiated sometime after those facilities for which the Pennsylvania Fish Commission has responsibility are installed but within the ten-year program as set forth in this work plan. Those facilities for which the Department of Forests and Waters are responsible for providing local costs include all of those in Table 2b with the exception of the specific items set forth as a Pennsylvania Fish Commission responsibility in the preceding paragraph.

The Beavertown Borough Council will be responsible for securing land rights on site PA-638, for the construction and engineering services' costs allocated to the water supply facilities, and for the administration of contracts.

The Spring Township Supervisors will be responsible for the acquisition of land rights and administration of contracts for PA-639.

The Middleburg Borough Council will be responsible for acquisition of land rights and for administration of contracts for PA-640.

No land on which cost sharing has been provided will be sold or otherwise disposed of for the evaluated life of the project except to a public agency which will continue to operate and maintain the development in accordance with the Operation and Maintenance Agreement.

The Snyder County Commissioners will acquire or provide assurance that landowners or water users have acquired such water rights as may be needed in the installation and operation of PA-636, and will be responsible for securing the necessary permits from the Water and Power Resources Board of the Pennsylvania Department of Forests and Waters for construction of PA-636.

The Beavertown Borough Council will acquire or provide assurance that landowners or water users acquire such water rights as may be needed in the installation and operation of PA-638 and will be responsible for securing the necessary permits from the Water and Power Resources Board of the Pennsylvania Department of Forests and Waters for construction of PA-638.

The Spring Township Supervisors will acquire or provide assurance that landowners or water users have acquired such water rights as may be needed in the installation and operation of PA-639 and will be responsible for securing the necessary permits from the Water and Power Resources Board of the Pennsylvania Department of Forests and Waters for construction of PA-639.

The Middleburg Borough Council will acquire or provide assurance that landowners or water users have acquired such water rights as may be needed in the installation and operation of PA-640 and will be responsible for securing the necessary permits from the Water and Power Resources Board of the Pennsylvania Department of Forests and Waters for construction of PA-640.

The Penna. Fish Commission will acquire or provide assurance that landowners or water users have acquired such water rights as may be needed in the installation and operation of PA-637. The Penna. Department of Forests and Waters will be responsible for securing the necessary permits from the Water and Power Resources Board of the Penna. Department of Forests and Waters for construction of PA-637.

The Pennsylvania Fish Commission, the Snyder County Commissioners, Middleburg Borough Council, Spring Township Supervisors, and the Beavertown Borough Council have the right of eminent domain and will exercise it if necessary for the acquisition of land, easements and rights-of-way.

FINANCING PROJECT INSTALLATION

Federal assistance for carrying out the works of improvement on non-Federal land as described in this work plan will be provided under the authority of the Watershed Protection and Flood Prevention Act, Public Law 566, (83rd Congress, 68 Stat. 666), as amended.

The Pennsylvania Fish Commission will provide funds for carrying out its responsibilities from its allocation of Project 70 funds and from the general budget. The Pennsylvania Department of Forests and Waters will provide funds for carrying out its responsibilities from its general appropriation.

Middleburg Borough Council, Snyder County Commissioners, Beavertown Borough Council, and Spring Township Supervisors will provide funds for carrying out their responsibilities from Project 70 funds, general funds, or taxation. It is expected that interested individuals and businesses will contribute to the local cost.

The Snyder County Commissioners and the Pennsylvania Department of Highways will enter into agreement on apportioning the costs of raising that portion of Route LR 54025 affected by structure PA-636. The Snyder County Commissioners will enter into necessary agreements with the Spring Township Supervisors for abandonment and flooding easements of those township roads affected by structure PA-636.

The Pennsylvania Fish Commission will enter into an agreement with the Adams Township Supervisors for abandonment or flooding easements required for those township roads affected by PA-637.

The Snyder County Commissioners have agreed to provide financial support to the Spring Township Supervisors for the cost of administering the contracts. This financial assistance is limited to a sum not to exceed \$1,000, which is the estimated cost of administering the contracts for PA-639.

The Soil and Water Conservation Loan Program of the Farmers Home Administration is available to all eligible farmers in the watershed.

The Snyder County Agricultural Stabilization and Conservation Committee in administering the Agricultural Conservation Program Service will assist in the land treatment program through cost sharing. It is estimated that \$16,000 of Agricultural Conservation Program Service cost sharing funds will be needed annually for this purpose. The actual determination of how much assistance can be provided will be made on an annual basis and will be influenced by the needs and desires of the landowners. The sponsoring local organization, the County Agricultural Stabilization and Conservation Committee, the Pennsylvania Department of Forests and Waters, the U. S. Forest Service, and the Soil Conservation Service will, on an annual basis, determine how each can best contribute in carrying out an accelerated land treatment program in the watershed.

The total cost of installing forest land treatment measures is estimated to be \$38,800. Technical assistance to forest landowners for the installation of these measures will amount to \$18,800. This expenditure will be shared equally by the State and Federal government. The remaining \$20,000 includes \$8,700 to be contributed by the State for tree seedlings furnished the landowners and cost of cultural work to be completed on State-owned lands. The balance of \$11,300 is the installation costs to the landowners.

Financial and other assistance to be furnished by the Soil Conservation Service in carrying out the watershed work plan is contingent on the availability of funds for this purpose.

Financial and other assistance to be furnished by the Pennsylvania Fish Commission and the Pennsylvania Department of Forests and Waters in carrying out their responsibilities as set forth in the watershed work plan is contingent on the availability of funds for this purpose.

PROVISIONS FOR OPERATION AND MAINTENANCE

Land Treatment

Land treatment measures for both open land and forest land will be maintained by the landowners or operators of the land on which these measures are installed. Maintenance and treatment measures will be promoted and encouraged through the Soil and Water Conservation District program with technical assistance furnished by the Soil Conservation Service and other federal, state, and local organizations.

The forest land treatment measures will be operated and maintained by the landowners with technical assistance provided by the Pennsylvania Department of Forests and Waters in cooperation with the U. S. Forest Service under the going Cooperative Forest Management Program. Other Federal-State cooperative forestry programs will continue after the installation period.

Structural Measures

The Snyder County Commissioners will be responsible for operation and maintenance of PA-636 at an estimated annual cost of \$800. Middleburg Borough Council will be responsible for operation and maintenance of PA-640 at an estimated annual cost of \$3,850.

The Beavertown Borough Council will be responsible for operation and maintenance of PA-638 at an estimated annual cost of \$500. The Spring Township Supervisors will be responsible for operation and maintenance of PA-639 at an estimated annual cost of \$1,170.

The annual operation and maintenance costs of PA-637 are estimated to be \$21,045. Of this amount \$700 has been allocated to flood prevention with the remainder allocated to recreation. The Pennsylvania Fish Commission will be responsible for operation and maintenance from

the time PA-637 is constructed until the Pennsylvania Department of Forests and Waters constructs the recreation facilities. At that time the Department of Forests and Waters will assume operation and maintenance responsibilities for PA-637 and all of the recreation facilities except for the management of the fishery resources which will remain the responsibility of the Pennsylvania Fish Commission.

The Pennsylvania Department of Forests and Waters will maintain the area as a state park and will provide the same type of custodial, policing, sanitation, safety, and other operational services as provided at similar facilities under their management. Costs for periodic replacement of the recreation facilities have been developed. The estimated annual operation and maintenance costs include \$15,200 for labor, \$2,000 for maintenance equipment and \$3,145 as annual replacement cost for the recreation facilities.

All structural measures should be inspected after every major storm and will be inspected at least once a year. Representatives of the sponsoring local organizations responsible for operation and maintenance and the Soil Conservation Service will jointly make the required annual inspection. A report including recommendations for repairs, improvements and replacements will be prepared and filed for each inspection.

The structural works of improvement will be operated in such a manner that they will serve the purpose, both as to function and time, for which they are installed.

The maintenance will consist of, but not be limited to, the following:

1. Remove and burn debris.
2. Refill, smooth and vegetate rilling on embankments, spillways, and drainage ways.
3. Realign disposal channels.
4. Repair damaged riprap, concrete or other works.
5. Repair fences and gates.
6. Maintain good sod covers.

Specific maintenance agreements will be entered into prior to the execution of the project agreement for works of improvement.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST

Middle Creek Watershed, Pennsylvania

Installation Cost Item	To Be Treated		Estimated Cost ^{1/}		
	Unit	Non-Federal Land Number	P. L. 566 Dollars	Other Dollars	Total Dollars
<u>Land Treatment</u>					
<u>Soil Conservation Service</u>					
Cropland	acre	4,310	-	139,830	139,830
Grassland	acre	2,900	-	63,420	63,420
Wildlife-Recreation	acre	400	-	15,920	15,920
Technical Assistance			59,540	54,320	113,860
SCS Subtotal			59,540	273,490	333,030
<u>Forest Service</u>					
Woodland	acre	1,265	-	20,000	20,000
Technical Assistance			9,400	9,400	18,800
FS Subtotal			9,400	29,400	38,800
TOTAL LAND TREATMENT			68,940	302,890	371,830
<u>Structural Measures</u>					
<u>Soil Conservation Service</u>					
Floodwater Retarding Structures	each	1	611,471	-	611,471
Floodway	feet	1,000	39,000	-	39,000
Dike	feet	1,970	128,394	-	128,394
Multiple Purpose Structures	each	2	621,051	113,089	734,140
Basic Recreation Facilities	each	1	223,360	223,359	446,719
Subtotal - Construction			1,623,276	336,448	1,959,724
<u>Installation Services</u>					
<u>Soil Conservation Service</u>					
Engineering Services			236,546	35,584	272,130
Other			84,898	-	84,898
Subtotal - Installation Services			321,444	35,584	357,028
<u>Other Costs</u>					
Land, Easements & R/W			62,475	297,743	360,219
Administration of Contracts			-	26,500	26,500
Subtotal - Other			62,475	324,243	386,718
TOTAL STRUCTURAL MEASURES			2,007,195	696,275	2,703,470
TOTAL PROJECT			2,076,135	999,165	3,075,300
<u>SUMMARY</u>					
Subtotal - SCS			2,066,735	969,765	3,036,500
Subtotal - FS			9,400	29,400	38,800
TOTAL PROJECT			2,076,135	999,165	3,075,300

^{1/} Price Base - 1964

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TABLE 1A - STATUS OF WATERSHED WORKS OF IMPROVEMENT

Middle Creek Watershed, Pennsylvania

Measures	Unit	Applied To Date	Total Cost (Dollars) ^{1/}
<u>LAND TREATMENT</u>			
Conservation Cropping System	acre	647	13,068
Diversions	feet	30,965	8,050
Drainage Field Ditch	feet	42,110	9,896
Grassed Waterway or Outlet	acre	9	3,600
Strip Cropping	acre	1,300	7,150
Tile Drain	feet	53,682	11,810
Pasture and Hayland Planting	acre	877	38,588
Pasture and Hayland Renovation	acre	65	2,860
Wildlife Habitat Development	acre	52	1,560
Tree Planting	acre	69	3,864
Hydrologic Cultural Operations	acre	346	7,800
Woodland Grazing Control	acre	5	100
Skid Trail and Logging Road Erosion Control	acre	80	800
Farm Ponds	no.	10	<u>5,000</u>
TOTAL LAND TREATMENT			111,982

^{1/} Price Base - 1964

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TABLE 2 - ESTIMATED STRUCTURE COST DISTRIBUTION

Middle Creek Watershed, Pennsylvania

(Dollars) 1/

Structure Site No. or Name	Installation Cost - P.I. 566 Funds				Installation Cost - Other Funds					Total Inst. Cost	
	Construction	Instal. Services Engin- eering	Ease- ments & R/W	Total P.I. 566	Construction	Instal- lation Services	Other				
							Admin. of Con- tracts	Ease- ments & R/W			
PA-636	611,471	71,618	29,613	-	712,702	-	-	7,000	180,738	187,738	900,440
PA-637	346,037	52,245	23,439	56,850	478,571	91,155	-	6,000	86,880 <u>2/</u>	184,035	662,606
Basic Recreation Facilities	223,360	31,270	-	5,625	260,255	223,359	31,271	6,000	6,975 <u>4/</u>	267,605	527,860
PA-638) Joint Cost) Specific Cost <u>2/</u>	275,014	44,586	16,446	-	336,046	19,434 2,500	4,313	4,000	15,150	42,897 2,500	378,943 2,500
PA-639	39,000	8,580	3,588	-	51,168	-	-	1,000	4,500	5,500	56,668
PA-640	128,394	28,247	11,812	-	168,453	-	-	2,500	3,500	6,000	174,453
GRAND TOTAL	1,623,276	236,546	84,898	62,475	2,007,195	336,448	35,584	26,500	297,743	696,275	2,703,470

1/ Price Base - 19642/ Specific cost to water supply3/ Includes \$19,500 for flowage easements and \$10,530 for survey and legal fees.4/ Includes \$1,350 for survey and legal fees.

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TABLE 2A - COST ALLOCATION AND COST SHARING SUMMARY

Middle Creek Watershed, Pennsylvania

(Dollars) $\frac{1}{2}$

	Purpose			
	Flood Prevention	Recreation	Water Supply	Total
<u>COST ALLOCATION</u>				
Single Purpose PA-636, PA-639 and PA-640	1,131,561	-	-	1,131,561
Multiple Purpose PA-637	325,515	864,951	-	1,190,466
PA-638	353,932	-	27,511	381,443
TOTAL	1,811,008	864,951	27,511	2,703,470
<u>COST SHARING</u>				
P. L. 566	1,567,374	439,821	-	2,007,195
Other	243,634	425,130	27,511	696,275
TOTAL	1,811,008	864,951	27,511	2,703,470

 $\frac{1}{2}$ Price Base - 1964

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TABLE 2B - ESTIMATED CONSTRUCTION COST OF RECREATIONAL FACILITIES

Middle Creek Watershed, Pennsylvania

(Dollars) 1/

Facility	Unit	Number	Unit Cost	Total Construction Cost
Picnic Unit (4 tables, fire rings, site preparation)	Unit	41	\$ 400	\$ 16,400
Swimming Beach	Sq.Ft.	73,450	.25/sq.ft.	18,400
Parking (stabilized area and guardrails)	Spaces	410	100	41,000
Boating (ramps, docks, site preparation)	Spaces	300	50	15,000
Sanitary Facilities	Unit	36	500	18,000
Water (treatment and distribution facilities)	--	--	--	213,000
Roads - main access	Miles	2	50,000	100,000
- laterals	Miles	2	10,000	20,000
Trails	Mile	.5	2,640	1,320
Signs and markers	--	--	--	514
Landscaping	--	--	--	3,085
TOTAL				\$ 446,719

1/ Price Base - 1964February 1965

TABLE 3 - STRUCTURE DATA

FLOODWATER RETARDING STRUCTURES AND WATER SUPPLY RESERVOIRS

Middle Creek Watershed, Pennsylvania

Item	Unit	Structure Number			Total
		PA-636	PA-637	PA-638	
Drainage Area	sq.mi.	33.15	17.59	5.30	56.04
Storage Capacity					
Sediment	ac.ft.	447	290	33	770
Recreation Development	ac.ft.	-	2,445	-	2,445
Water Supply	ac.ft.	-	-	56	56
Floodwater	ac.ft.	5,000	3,130	765	8,895
Total	ac.ft.	5,447	5,865	854	12,166
Between High and Low Stages	ac.ft.	2,120	-	-	2,120
Surface Area					
Sediment	acres	112	-	-	112
Recreation Development	acres	-	230	-	230
Water Supply	acres	-	-	12	12
Floodwater Pool	acres	405	390	46	841
Volume of Fill	cu.yd.	244,013	261,800	187,000	692,813
Elevation Top of Dam	feet	610	656	754	
Maximum Height of Dam	feet	42	51	60	
Emergency Spillway					
Crest Elevation	feet	598	644.1	743.5	
Bottom Width	feet	350	150	150	
Type		rock	rock & con.	rock	
Percent Chance of Use		1.0	1.0	1.0	
Ave. Curve No. (Cond. II)		76.5	75	66	
Emergency Spillway Hydrograph					
Storm Rainfall (6 hr.)	inch	9.9	9.9	9.9	
Storm Runoff	inch	9.0	8.81	7.94	
Velocity of Flow	ft./sec.	10.8	9.4	9.8	
Discharge Rate	c.f.s.	14,100	4,200	5,100	
Max. Water Surface Elevation	feet	604.0	648.9	748.8	
Freeboard Hydrograph					
Storm Rainfall (6 hr.)	inch	25.2	25.4	25.4	
Storm Runoff	inch	21.85	21.79	20.12	
Velocity of Flow	ft./sec.	15.6	15	14.1	
Discharge Rate	c.f.s.	44,800	18,700	15,900	
Max. Water Surface Elevation	feet	609.8	655.8	753.9	
Principal Spillway					
Capacity - Low Stage	c.f.s.	494	-	-	
Capacity - High Stage	c.f.s.	1,292	542	180	
Capacity Equivalent					
Sediment Volume	inch	0.252	0.31	0.118	
Detention Volume	inch	2.83	3.34	2.71	
Spillway Storage	inch	3.56	5.67	2.01	
Class of Structure		c	c	c	

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TABLE 3A - STRUCTURE DATA (DIKE)
PA-640 - Middle Creek Watershed, Pennsylvania

Station Numbering Sta.	Sta.	Top Width (feet)	Ave. Side Slope	Ave. Ht. of Dike (feet)	100 Yr. Freq. Velocity (ft/sec)	5 Yr. Freq. Velocity (ft/sec)	Volume of Earth Fill (Cu.Yd.)	Volume Concrete (Cu.Yd)
10+20	11+10	14	3:1	3.4	0 /1	0 /1	356	
11+10	13+50	14	3:1	6.1	0 /1	0 /1	2,028	
13+50	15+80	14	3:1	5.7	0 /1	0 /1	1,794	
15+80	19+00	14	3:1	3.9	0 /1	0 /1	1,424	
19+00	20+00	14	3:1	4.3	0 /1	0 /1	510	
20+00	20+60	14	3:1	4.2	7.5	0	297	
20+60	21+00	14	3:1	3.1	7.5	0	128	8
21+00	25+00	14	3:1	2.2	7.5	0	880	88
25+00	26+00	14	3:1	3.7	6.5	2	455	
26+00	27+00	14	3:1	5.55	6.5	2	720	
27+00	28+00	14	3:1	6.2	6.5	2	850	
28+00	28+90	14	3:1	5.7	6.5	2	756	
28+90	29+90	1	Vertical	2.3	6.5	2	---	85
Total							10,198	181

/1 Dike subjected to backwater only.

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TABLE 3B - STRUCTURE DATA (Channels)
 Beaver Springs Floodway Channel PA-639
 Middle Creek Watershed, Pennsylvania

Station	Drainage Area Sq. Mi.	Required Capacity c.f.s.	Manning's "n" Value Present Design	Bottom Width (ft)	Side Slopes	Hydraulic Gradient ft./ft.	Water Surface Elevation	Design Depth (ft)	Velocity at Design Depth (fps)	Flow Area @ Design Depth (sq. ft.)		Cap.at Design Depth (cfs)		Volume of Excav. Earth Yds.		Rock 3/ Yds.	Stability Check As Constructed 2/ Flow Conditions 2/ Vel. (fps)	
										Chan.	Seg.	O.B.	Depth	3/ Yds.	3/ Yds.		Flow	Vel.
2+00	1.26	380	-	.030	30	1:1	588.1	2.4	4.88	78	-	380	130	-	150	3.50		
4+00	1.26	380	-	.030	30	1:1	587.5	2.5	4.88	78	-	380	356	-	150	3.50		
6+00	1.26	380	-	.030	30	1:1	587.0	2.7	4.32	88	-	380	315	-	150	3.39		
8+00	1.26	380	-	.030	30	1:1	586.6 <u>3/</u>	3.1	3.68 <u>4/</u>	103	-	380	386	-	150	2.91		
10+00	1.26	380	-	.030	30	1:1	586.6 <u>3/</u>	3.8	2.97 <u>4/</u>	128	-	380	600	-	150	2.17		
12+00	1.26	380	-	.030	30	1:1	586.6 <u>3/</u>	4.5	2.15 <u>4/</u>	155	-	380	693	-	150	1.64		

1/ Design values based on downstream stationing.

2/ Stability based on 5 year-frequency flow.

3/ Water surface elevation controlled by backwater of 100 year discharge on Beaver Creek.

4/ Velocity based on 380 cfs in area controlled by backwater of Beaver Creek.

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TABLE 4 - ANNUAL COST
Middle Creek Watershed, Pennsylvania
(Dollars) 1/

Evaluation Unit	Amortization of Installation Cost <u>2/</u>	Operation and Maintenance Cost <u>4/</u>	Total
PA-636, PA-637 PA-637 M.B.F., PA-638 and PA-640	86,710	26,195	112,905 <u>3/</u>
PA-639	1,855	1,170	3,025
TOTAL	88,565	27,365 <u>5/</u>	115,930

1/ Price Base - 1964.

2/ Amortized at 3 1/8 percent for 100 years.

3/ Includes \$37,635 annual costs for recreation facilities.

4/ Long term price level as projected by Agricultural Research Service Projection, September 1957.

5/ Includes \$20,345 annual cost for operation and maintenance of recreation facilities.

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TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS

Middle Creek Watershed, Pennsylvania

(Dollars) 1/

Item	Estimated Average Annual Damage Without Project	Estimated Average Annual Damage With Project	Damage Reduction Benefit
Floodwater			
Crop & Pasture	2,376	163	2,213
Other Agriculture	539	0	539
Non-Agriculture			
Residential	26,462	480	25,982
Commercial	42,402	866	41,536
Bridge & Road	<u>3,101</u>	<u>9</u>	<u>3,092</u>
Subtotal	74,880	1,518	73,362
Indirect	13,360	262	13,098
Total	88,240	1,780	86,460
Benefits outside the watershed			5,095
Total monetary benefits F.P.			91,555

1/ Long term prices.February 1965

TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES

Middle Creek Watershed, Pennsylvania

(Dollars) $\frac{1}{2}$

Evaluation Unit	Average Annual Benefits					Avg. Annual Cost	Benefit Cost Ratio
	Flood Prevention		Municipal Water Supply	Other	Total		
	Damage Reduction	More Intensive Land Use					
PA-636, PA-637 and MBF PA-638 PA-640	64,365	3,135	7,200	223,200	297,900	112,905 ^{2/}	2.6 to 1.0
PA-639	21,805			2,350	24,155	3,025	8.0 to 1.0
GRAND TOTAL	86,170 ^{3/}	3,135	7,200	225,550 ^{4/}	322,055	115,930	2.8 to 1.0

$\frac{1}{2}$ Price Base - 1964 - Long term price level as projected by Agricultural Research Service Price Projection, September 1957 used for benefits.

$\frac{2}{2}$ Includes \$37,365 annual costs for recreation facilities.

$\frac{3}{2}$ In addition it is estimated that land treatment measures will provide flood damage reduction benefits of \$2,250 annually.

$\frac{4}{2}$ Other includes:

Recreation Benefits	\$190,000
Redevelopment Benefits	8,900
Secondary Benefits	26,650

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Hydrologic

The watershed was analyzed using procedures outlined in the Soil Conservation Service National Engineering Handbook, Hydrology Section, and Supplement A to the Hydrology Section. Peak discharges at various damage centers were derived by runoff resulting from the weighted rainfall of several Weather Bureau Stations located outside of the watershed. The frequency analysis was made using rainfall from U. S. Department of Commerce, Weather Bureau Technical Paper #40, and the average antecedent soil moisture condition for the watershed.

Synthetic hydrographs were routed to various damage centers to obtain peak discharges. These peak discharges were checked by highwater marks produced by the November, 1956 key flood. There is no stream gauge on Middle Creek. Penn Creek, located north of and adjacent to Middle Creek, has a stream gauge with a 34-year record. This information was used in evaluating the hydrologic characteristics of the Middle Creek watershed.

Rainfall-runoff relationships were determined from a study of the soil and vegetative cover. A tabulation of the soil type and hydrologic characteristics was supplied by the work unit conservationist. The U. S. Forest Service and the Pennsylvania Department of Forests and Waters supplied hydrologic data on the forest land and forest land cover complex numbers. Information was collected in a series of field plots, selected systematically, where measurements of litter, humus, soil type, and other hydrologic factors were recorded and analyzed.

Three storms of varying magnitude were routed to the damage centers by the Wilson Method. The 100-year frequency of occurrence event was also routed by the storage-indication method as a check on the routing procedure. This information was used to establish a relationship between peak discharge and rainfall as reported in U. S. Weather Bureau Technical Paper #40. From this relationship, peak discharge versus frequency of occurrence curves were computed for each damage reach.

The above analysis was repeated assuming the proposed works of improvement installed to determine their effects on flood frequency and magnitude. The effect of future runoff with the proposed land treatment was evaluated.

The magnitude of the November 2, 1956 key flood has been exceeded several times in the long history of flooding on Middle Creek watershed. There have been seven storms of approximately equal stages at various damage centers since 1930. The storm of August 24, 1933 was approximately two feet higher at several points on the flood plain. The flood which occurred in June, 1889 is the greatest storm of record.

Design Hydrology

The flood storage requirements were determined by routing the

uncontrolled area hydrograph through the damage centers and delaying the second stage discharge from the structures so that it would not increase the peak discharge. The second stage maximum discharge was determined by considering the capacity of the channels downstream from the proposed structures and drawdown time of the floodwater retarding structures.

The emergency spillways were designed to safely pass the peak discharge produced by the six-hour precipitation for Class "C" structures. This precipitation was considered falling on previously saturated soil moisture condition, which amounts to a six-hour point rainfall of approximately ten inches. The freeboard elevation was determined by reservoir routing the hydrograph produced by a six-hour precipitation for developing the freeboard hydrograph for Class "C" structures. This precipitation was considered falling on average antecedent soil moisture conditions for the watershed and is approximately 25.5 inches point rainfall for this area.

Hydraulic

Fourteen reaches were used to evaluate damages in the watershed. Economic situations and stream characteristics were considered in selection and rating of these various reaches. Stage versus discharge curves were prepared for the reference section at each reach. Water surface profile elevations were computed by a digital computer for 19 miles of the main flood plain of Middle Creek. Water surface profile computations were made using the step method outlined in Supplement A to Hydrology Section for other reaches in the watershed.

The procedure outlined in Engineering and Watershed Planning Memorandum #34, Hydrology 3, was used to evaluate the effects of land treatment. All of the floodwater retarding structures were designed to have a two-stage riser configuration. This was determined by routing the peak discharge from the uncontrolled drainage area through the damage centers before releasing the maximum discharge from the floodwater retarding structures.

Engineering

The dam sites were selected on the basis of a study of the U. S. Geologic Survey topographic maps of the watershed, a field study of specific site conditions, and a study of estimated federal and local costs, based on preliminary structural designs, of several site combinations. Ten dam sites were carefully considered during the study.

The procedure for the preliminary design of the dams was as follows:

1. Aerial photographs were obtained for six sites. Four-foot contour interval topographic maps were prepared for these sites by means of the Kelsh Plotter to a scale of 200 feet to the inch. The maps were checked and completed in the field by a planetable survey crew. Four additional sites

were surveyed by transit or planetable crews. All surveys were based upon mean sea level datum.

2. The stage-area and stage-storage curves were developed from each map.
3. From the stage-storage curve, the crest of the low stage inlet of the principal spillway was set at the sediment pool elevation.
4. The floodwater detention and principal spillway requirements were determined by the hydrologist.
5. The elevation of the crest of the emergency spillway was determined by adding the storage computed in step 4 to the total sediment storage and applying this storage to the stage-storage curve.
6. In selecting the bottom width of the emergency spillway, the following items were considered:
 - a. Permissible velocity of flow through the spillway.
 - b. Minimum rock excavation.
 - c. Utilization of excavated material in the embankment.
 - d. Minimum total cost of the project. The emergency spillway hydrograph was routed through the structure using emergency spillways of various widths, by the parabolic method described in Technical Release #2, Design Section. From these trial routings, the emergency spillway dimensions were determined.
7. The top of dam elevation was determined by flood routing the freeboard hydrograph through the structure by Method 2 described in Section 5.8, National Engineering Handbook, Hydraulics.
8. The preliminary design quantities used for estimating construction costs were determined for 11 items - clearing, clear and grub, fill (earth and rock), excavation (common and rock), pipe, concrete, filter, and drainage materials, rock riprap, fencing, and seeding.

Structures PA-636, 637, and 638 have been classified "C" structures according to Engineering Memorandum, SCS-27.

Preliminary structural dimensions are subject to change based on detailed geology and soil mechanics information which will be obtained prior to final design.

The following information is pertinent to the design and cost of each structure:

PA-636

PA-636 is designed with a three-to-one upstream and two-to-one downstream slope. A combination of a partial cutoff core and toe drains is planned to control seepage and uplift pressures. The feasibility of drilling a principal spillway tunnel through the left abutment may be studied in final design.

PA-637

PA-637 is designed as an earth and rock fill dam, with three-to-one upstream and two-to-one downstream slopes. A moderately deep cutoff core and a toe drain system are planned to control seepage and uplift pressures. The 150 foot emergency spillway will have a concrete paved section because it will be cut into highly weatherable shale.

PA-638

PA-638 is designed as an earth and rock fill dam, with three-to-one upstream and two-to-one downstream slope. A deep cutoff core and a foundation drainage system are planned to control seepage and uplift pressures. The 150 foot emergency spillway will be positioned so the control section is constructed in the durable Keefer sandstone formation.

PA-639

A map study was made of alternate locations for the floodway, PA-639, at Beaver Springs, from a topographic survey of the area west of Beaver Springs and south of U. S. Route 522. Factors which determined the design and influenced the location of the waterway were the following: in-bank flow of 100-year frequency storm, permissible channel velocities, and minimum total cost of the project. Local factors which were evaluated in the selection of the floodway location included the expansion plans of the Dairyman's Cooperative Milk Plant, the plans of the Pennsylvania Railroad to abandon its line in this area, and the future plans of the Kinney Shoe Factory.

The floodway was designed within the framework of the factors just mentioned. One-to-one bank slopes were selected for the floodway and riprap was specified to be placed on the banks for slope stability, to assure a minimum of maintenance and to maintain the straight alignment of the floodway. The floodway channel bottom was designed to be bare earth to improve flow characteristics and to minimize the maintenance requirements.

The cost of PA-639 was based on the following items: common excavation, rock riprap, concrete, seeding, and fill. The removal of the low dam north of U. S. Route 522 and the clearing and

snagging of the Beaver Creek channel between PA-639 and the low dam was included in the cost as a single item.

PA-640

The Middleburg dike, PA-640, was designed by the following procedure:

1. A topographic survey was made of Middle Creek channel and adjacent areas, beginning at the dam west of Middleburg and ending one-half mile east of the U. S. Route 522 bridge.
2. The proposed location of the dike was determined from a study of this map.
3. Channel cross sections, a low bank profile, and a channel bottom profile were drawn from the map and basic survey data.
4. The water surface profile was computed for the 100-year storm with PA-636, PA-637, PA-638, and the dike (PA-640) in place. With this information, a dike was designed to contain the 100-year storm, with two feet of freeboard.
5. Estimated construction costs were based on the following items: earth fill, concrete, excavation, drainage material, site dewatering, and internal drainage.

Final design for each project will be submitted to the Water and Power Resources Board of the Pennsylvania Department of Forests and Waters for approval.

Geology

A reconnaissance of land subject to flooding was made to determine the damages caused by sedimentation and erosion. Special studies were made on flood plain lands used for agricultural purposes; information was obtained regarding the depth and acidity of overwash, impairment of drainage features by sedimentation, and the scouring of flood plain lands.

Sediment storage requirements for the proposed floodwater dams were computed by procedures outlined in the Geology section of the Watershed Planning Guide. Factors taken into consideration were sheet erosion, channel erosion, delivery rate to the structure and trap efficiency of the reservoir. Sheet erosion was computed from Musgrave's Soil Loss Formula using basic data taken from soils maps, air photos, and field measurements. Sediment storage at each reservoir will contain the expected accumulation for a hundred-year period.

Preliminary geologic site investigations were made at each of the proposed dam sites in order to determine the subsurface conditions and the engineering characteristics of the materials at the sites.

The field procedures used in the preliminary geologic investigations of the sites included the use of a portable refraction seismograph, resistivity apparatus, manual sampling and exploration tools, and soil testing equipment. Data obtained from the field and laboratory were plotted on maps, cross sections, and profiles, and correlation was effected. Features such as bedrock profiles, soil types, and ground water levels were plotted and their relationship with the proposed works of improvement were shown. A plan and cost estimate of detailed geologic site investigations was prepared for each of the sites.

The preliminary geologic investigation of the proposed sites revealed the following conditions:

PA-636

The site is formed by a strike valley in yellow to gray, interbedded shale, siltstone and sandstones of the Mahantango formation, Devonian system. The flood plain and right abutment are mantled with a moderately deep cover of silty, sandy clay. Alluvial deposits were noted in the flood plain. The rock underlying the residual soil cover of the abutments is weathered to about ten feet deep and is very fractured and broken to the depth of weathering. Some leakage is anticipated through the rock foundation and cost estimates include provisions for controlling this condition. Rock excavation is anticipated in the proposed emergency spillway. Borrow for the proposed embankment is available near the site.

PA-637

The proposed multipurpose site is formed by a strike valley. The streambed follows less resistant shales of the Marcellus formation that are fractured, broken, distorted, and weathered to a moderate depth. The steep left abutment is formed of sandstone and shales of the Mahantango formation weathered to about 15 feet depth. The right abutment, where the proposed emergency spillway is located, is formed of Marcellus formation shales and limestones and shales of the Onondaga formation. Silty and sandy clays overlies both abutments and the flood plain. A line of springs emerge from shales at the base of the right abutment. Some seepage through the foundation is anticipated and costs to cover remedial treatment have been provided in cost estimates. Some rock excavation is anticipated in the construction of the emergency spillway. Ample borrow for the proposed embankment is available within the site.

PA-638

The site is formed by the intersection of Kern Run with sandstones and sandy shales of the Rose Hill and Keefer formations. The abutments are mantled with 2-3 feet of residual soils; the

flood plain has a covering of coarse cobbly alluvium. Seepage is expected through the foundation especially in the broken, jointed, deeply weathered Rose Hill formation.

Remedial treatment was considered in planning cost estimates. Rock excavation from the quartzitic Keefer sandstone is anticipated in construction of the emergency spillway. Abutment springs occur in the weathered portion of the Rose Hill formation. Suitable borrow can be obtained from the flood pool, emergency spillway excavation and from a post-glacial terrace just below the proposed structure.

PA-639

Seismic studies, auger borings, and backhoe trenches indicate the proposed bypass channel at Beaver Springs is underlain by 3-6 feet of firm, sandy clay. This residual soil is underlain by weathered limestone of the Tonoloway formation. Some wet alluvial silty sands and organic silts will be encountered in the vicinity of the pond near the confluence of the proposed bypass channel and Beaver Creek. No rock excavation is anticipated within the proposed grade line.

PA-640

The foundation of the proposed structure presents a variety of conditions. Seismic studies and auger borings along the centerline of the proposed dike indicate an underlying foundation of claystones, siltstone, and shales of the Wills Creek formation at a depth of 4-8 feet. Soil overburden is varied as indicated in the following table:

<u>Centerline Station</u>	<u>Soil Description</u>
10+00 - 20+60	Four to six feet of residual soils, from silty clay (CL) over weathered rock.
20+60 - 26+00	Two to three feet of dumped fill overlies two to three feet of ML-CL alluvium. This is underlain by four to six feet of gravel and sand river wash, then weathered rock.
26+00 - 30+50	Three to five feet of firm sand, silt and clay overlies up to ten feet of river wash sands and gravels. This is underlain by weathered shale.

Sediment storage for Site PA-636 is 447.4 acre feet with 405.4 acre feet in the sediment pool and the remainder in the flood pool. For Site PA-637 sediment storage is 290 acre feet with 264.4 acre feet in the sediment pool and the remainder in the flood pool. In Site PA-638 sediment storage is 33.4 acre feet with 30.2 acre feet in the sediment pool and the remainder in the flood pool.

A summary of pertinent details from the preliminary geologic investigation follows:

<u>Site #</u>	<u>Foundation Conditions</u>	<u>Emergency Spillway</u>	<u>Borrow Materials</u>
PA-636	2-5 ft. residual soils (ML-CL) over sandstones, siltstones, and shales, Mahantango formation.	Yellow and gray sandstone and sandy shales.	Sandy clay, and weathered rock.
PA-637	Residual soils (CL-SM) over sandy and clayey shales - 1-4 ft. flood plain alluvium Marcellus and Mahantango formation.	Black and gray shales and limestones - Marcellus and Onondaga formation.	Sandy clay, and weathered rock.
PA-638	2-3 ft. of sandy and bouldery clay over sandstone and shale, Rose Hill formation.	Sandy shale and quartzitic sandstone, Rose Hill and Keefer formation.	Sandy and gravelly clay and weathered rock.

Economics

The basic information on damages was obtained in the field from personal interviews with property owners and was recorded on flood damage schedules. This information was related to the flood of November 2, 1956. The sponsoring organizations cooperated in contacting approximately 100 percent of the owners and operators of industrial and commercial property, 75 percent of residential and 25 percent of agricultural property affected by floodwaters from Middle Creek and tributary streams. Damages for stages above and below the 1956 flood level were appraised in one foot increments. The damage estimates were tabulated by stages and converted to long-term prices using Agricultural Research Service Price Projection for the U. S. Department of Commerce Composite Construction Index.

All costs to be incurred during the ten-year installation period of the project were based on 1964 price levels. Operation and maintenance costs have been adjusted to long term values.

Floodwater damages and benefits were computed using the frequency method as described in Chapter 3, page 2 of the Economic Guide, Soil Conservation Service. Separate damage frequency analyses were developed for each reach using the stage frequency data provided in the hydrologic study. Damage and benefits affecting agriculture, residences and commercial property were computed under: (1) condition without the project, (2) conditions after installation of the proposed land treatment, and (3) conditions with all measures installed.

Recreation benefits were assigned to PA-636 and PA-637 based on a study of the population within a one-hour driving distance, availability of present water-oriented facilities in the area, and other pertinent factors. The total demand for day-use recreation facilities for the study area was 228,000. Present facilities consist of the Susquehanna River and Middle Creek Lake. The recreation use of the river because of pollution is restricted to boating, while Middle Creek Lake, operated by the Pennsylvania Fish Commission, is restricted to fishing use. It was estimated that recreation use at these facilities is 25,000 visitor days annually. It was estimated that on Site PA-637, because of the type of recreation facilities to be installed and the type of recreation activities being planned, the visitor day use would be 120,000 annually at a benefit of \$1.50 per day. On Site PA-636, facilities will not be comparable to those at PA-637. Therefore, it was estimated that visitor day use would be 10,000 annually at a benefit of \$1.00 per user day.

Redevelopment benefits were computed for employment that would not be utilized in the absence of the project. These benefits were predicated on the use of local unskilled labor during construction of the proposed project. These costs were computed at local prices and amortized over the life of the project. The redevelopment benefits from employment in the operation and maintenance phase of the project were also considered as project benefits. These benefits were limited to 20 years and amortized over the life of the project at 3 1/8 percent interest.

The value of local secondary benefits stemming from the project were considered to be equal to ten percent of the direct primary benefits. These benefits include delaying of home improvements, cancellation of business expansion, etc., because of present flood hazard.

Land Treatment

The land treatment program was developed by the Soil and Water Conservation District, the Soil Conservation Service, the U. S. Forest Service, the Pennsylvania Department of Forests and Waters, the Agricultural Stabilization and Conservation Committee, and the Agricultural Extension Service.

Basic data used in developing the land treatment program included records of conservation treatment by landowners in the watershed, land use trends as indicated by the Conservation Needs Inventory, census reports, crop reporting service reports, and information developed by the Pennsylvania Department of Agriculture. Records of the Soil and Water Conservation District and the Agricultural Stabilization and Conservation Service were also made available for the study.

The following table indicates present land use and estimates future land use (1975) with the program installed:

<u>Land Use Groups</u>	<u>Present Land Use Acres</u>	<u>Future Land Use Acres</u>
Cropland	25,200	20,400
Pasture	3,646	6,200
Woodland	53,400	54,200
Idle	1,100	500
Other	750	2,796
Total	<u>84,096</u>	<u>84,096</u>

FIGURE 1
SCHEMATIC VIEW OF TYPICAL STRUCTURE SECTION

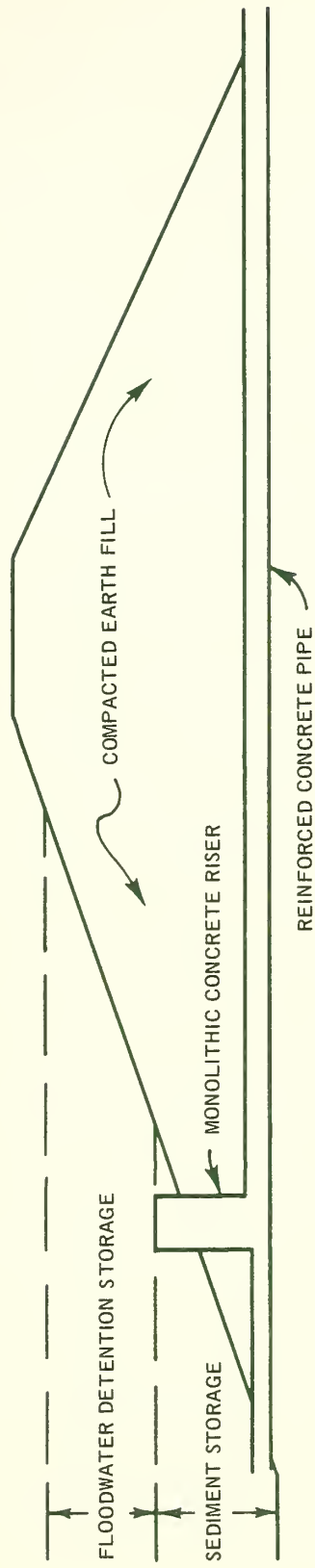
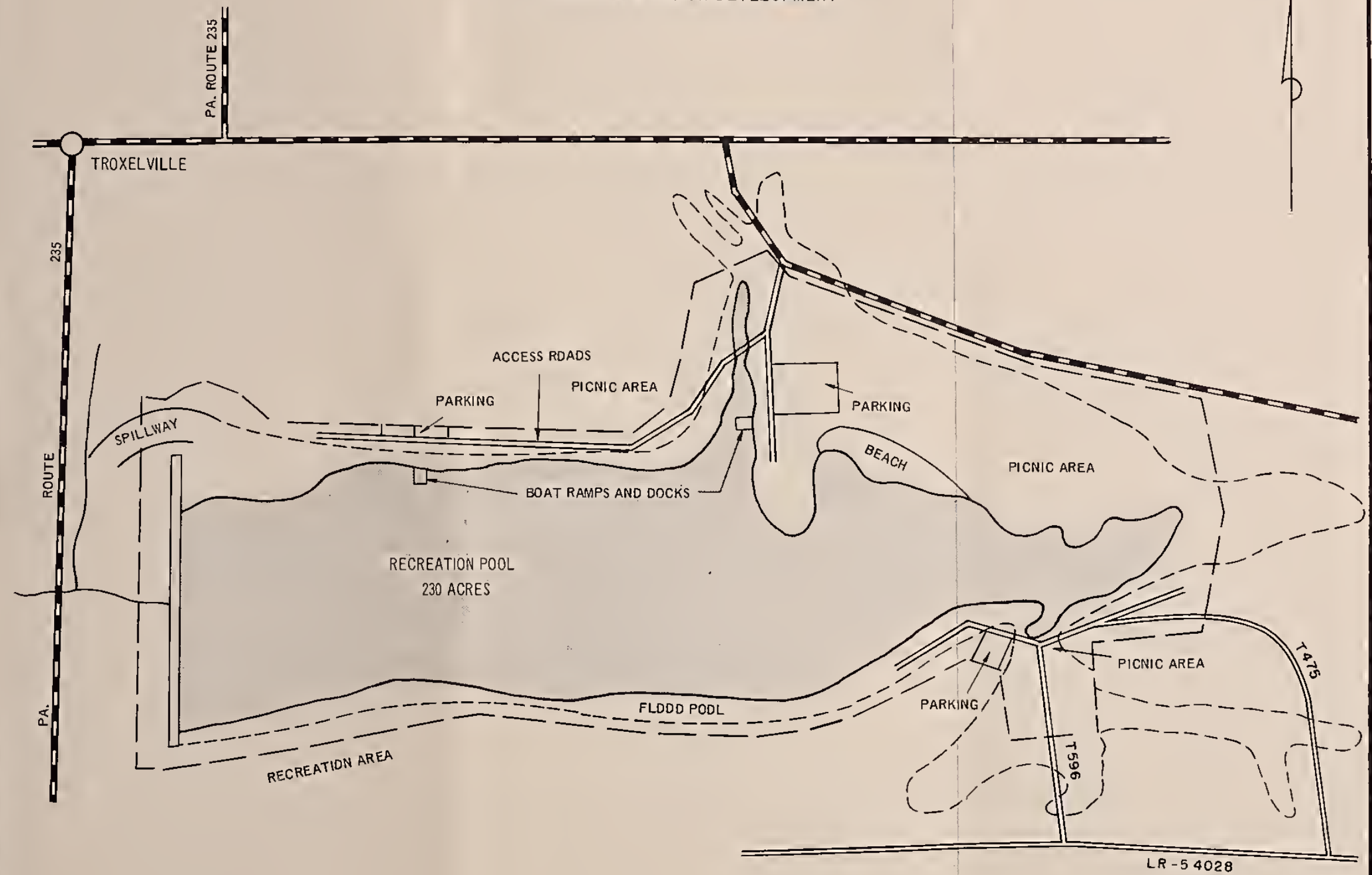
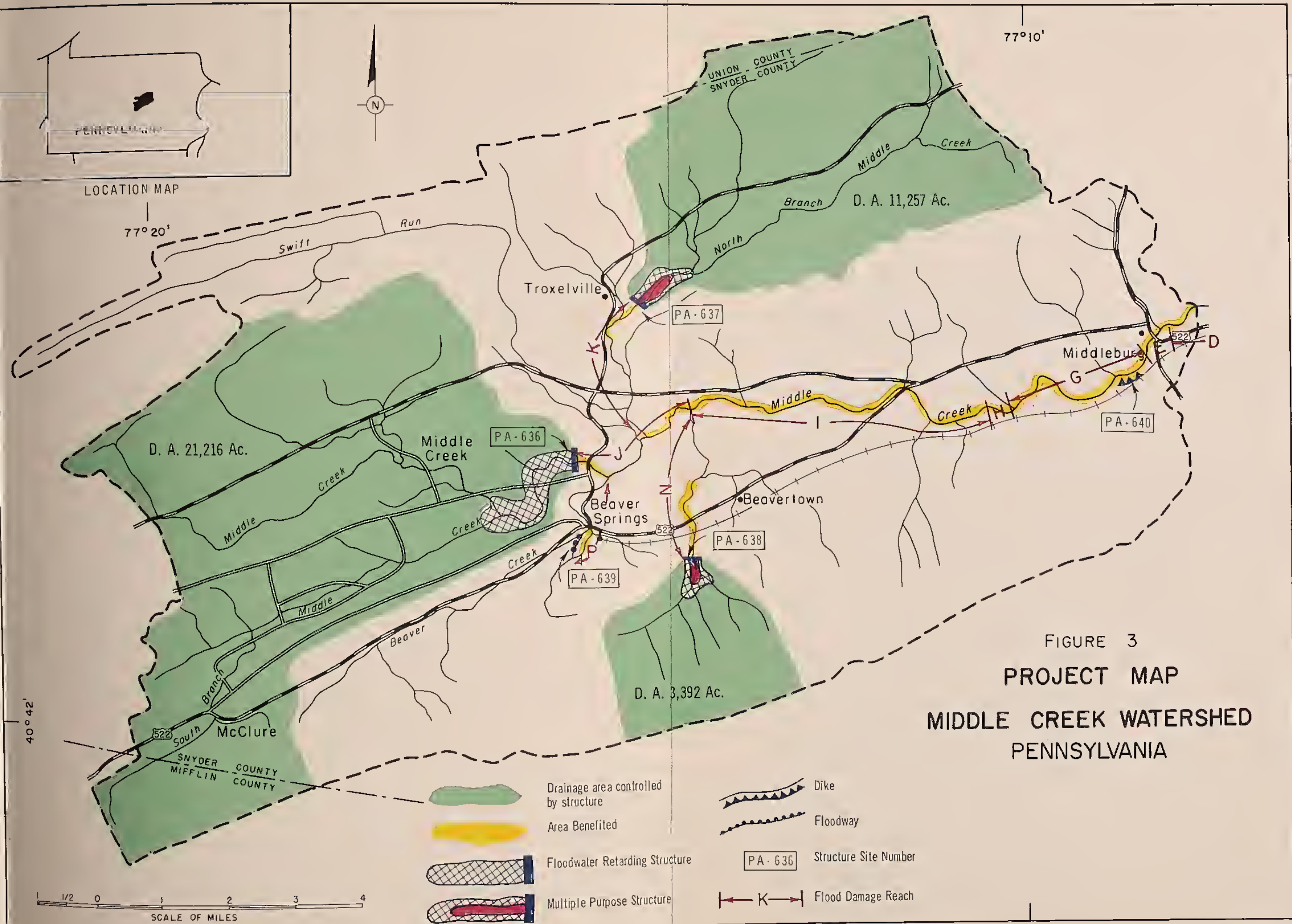


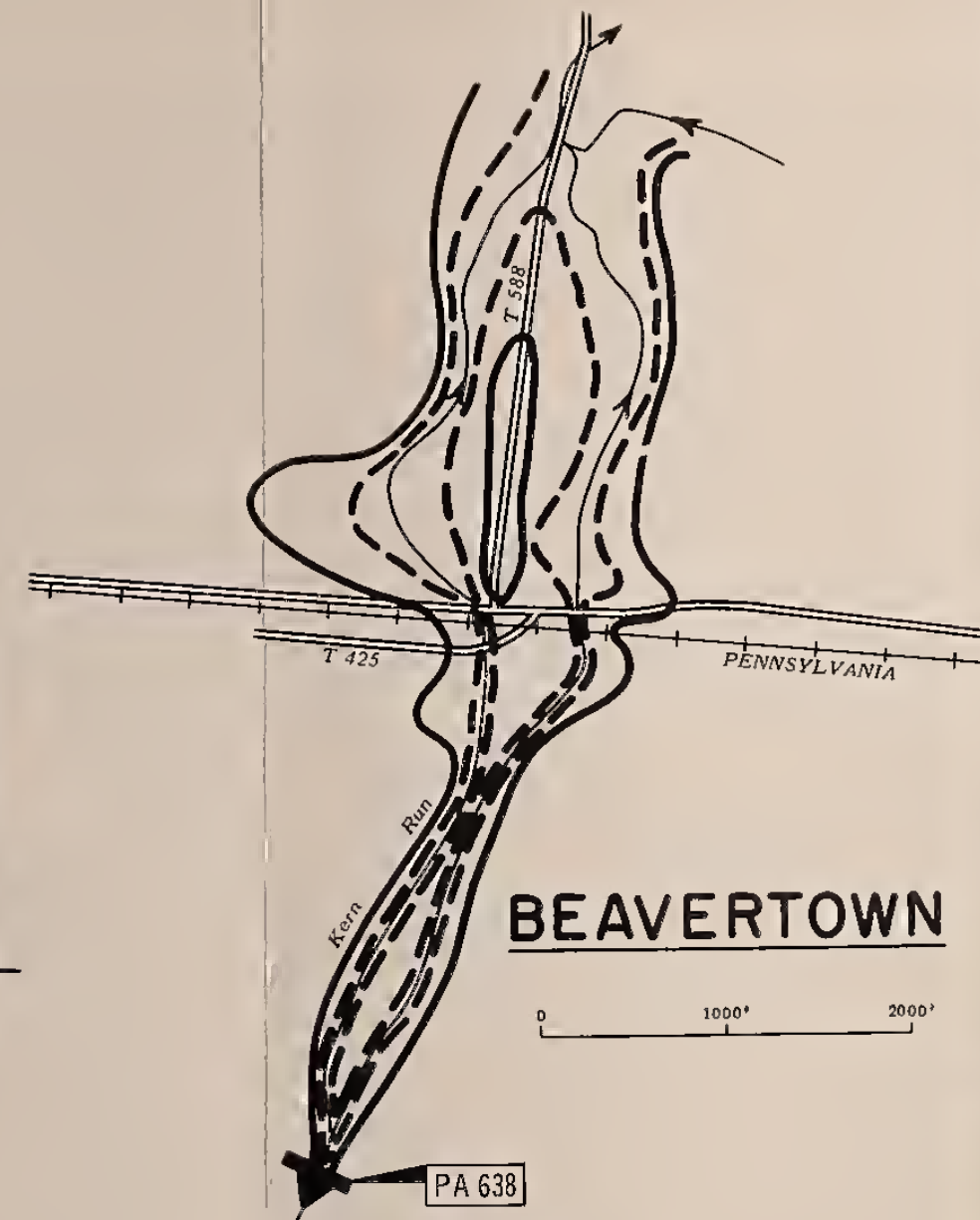
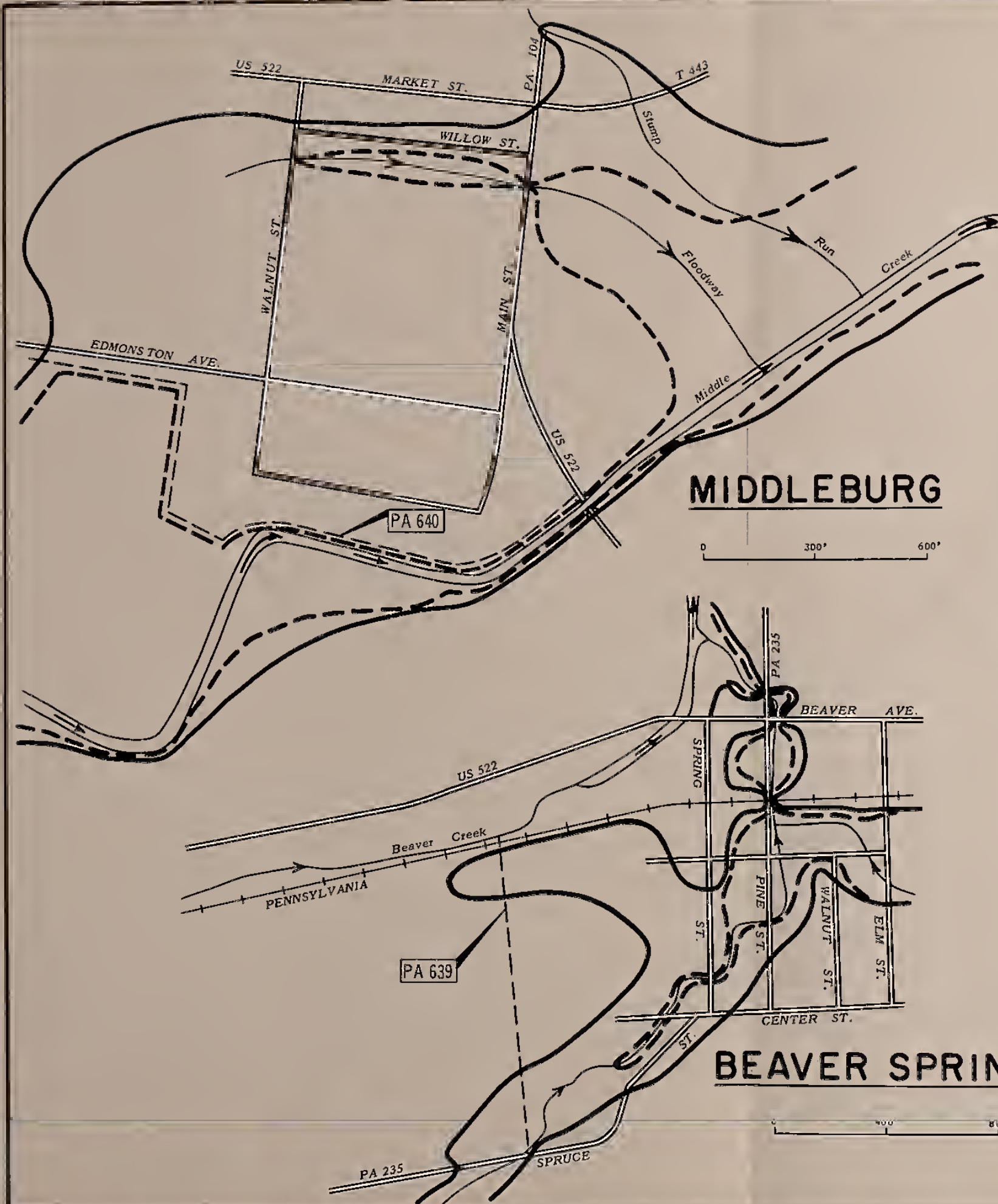
FIGURE 2

MIDDLE CREEK WATERSHED PROJECT

PA. 637 - RECREATION DEVELOPMENT







LEGEND

- 100-Year Flood High Water Line
- - - - - Controlled 100-Year Flood High Water Line

FIGURE 4
FLOOD FREQUENCY MAP
MIDDLE CREEK WATERSHED
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